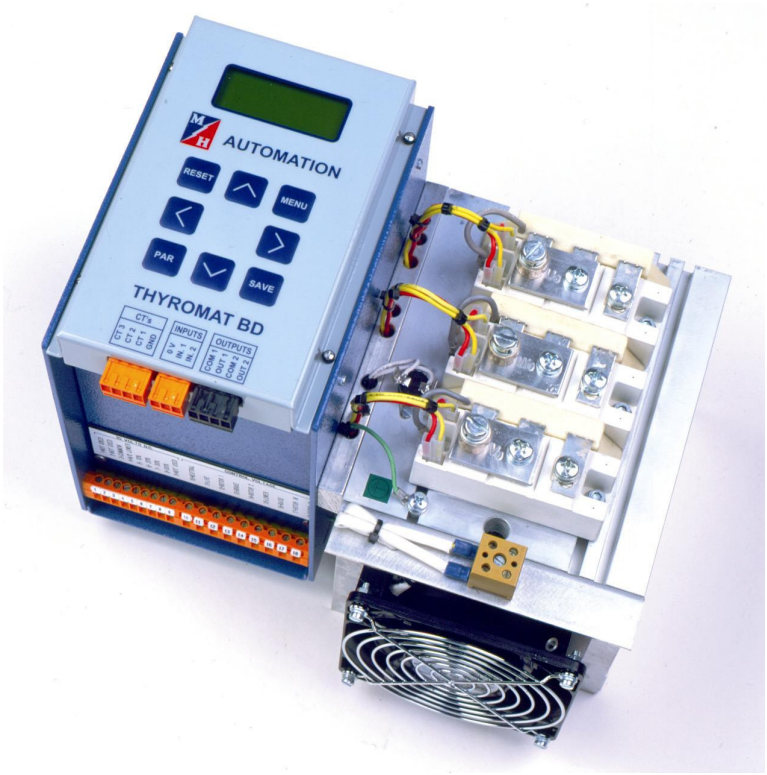
Automation International

THYROMAT-BD Digital Crane Controller



USER MANUAL

THYROMAT BD DIGITAL CRANE CONTROLLER
TABLE OF CONTENTS

1 GENERAL 1

1.1 CONTROL SYSTEM 1

1.1.1 Basic System Diagram 3

1.1.2 THYROMAT Components Identification 4

2 SECTION 2 : SYSTEM DESIGN 5

2.1. GENERAL 5

2.2. THYROMAT BD DIGITAL CRANE CONTROLLER RANGE 5

2.3. PROTECTION 7

2.4. THYROMAT - BD DIGITAL CRANE CONTROLLER SELECTION 7

2.4.1 Standard Duty 7

2.4.2 Severe Duty (Based on 40% of nominal load permanently on hook) 8

2.5. PRINCIPLE OF OPERATION 9

2.5.1. Control Box 10

2.5.2. Control Card 10

2.5.3. Relay Card 11

2.5.4. Phase Shifter Card 11

2.5.5. Snubber Card 11

2.5.6. Control Panel 11

2.6. CONTROL SYSTEM SPECIFICATIONS 12

2.7. THYROMAT - BD DIGITAL CRANE CONTROLLER ENCLOSURES 13

2.8. SELECTION OF RESISTORS 14

2.9. SELECTION OF MAINS CIRCUIT BREAKERS 16

2.10. SELECTION OF INTERPOSING INPUT RELAYS 18

2.11. SELECTION OF INTERPOSING OUTPUT RELAYS 18

2.12. SELECTION OF CABLES 19

2.12.1. Power Supply Cables 19

2.12.2 Control Power Cables 19

2.13. SELECTION OF STATOR REVERSING CONTACTORS 19

2.13.1. Contactor Switching Times 21

2.13.2. Contactors Drop Out Times 21

2.14. SELECTION OF CURRENT TRANSFORMERS 21

2.15. SELECTION OF ROTOR CONTACTORS....22

2.15.1. Star Connections....22

2.15.2. Delta Connections....22

2.15.3. V Connections....23

2.15.4. W Connections....23

2.16. MOTOR THERMAL PROTECTION UNIT - This feature is not yet implemented 23

2.17. SELECTION OF SPARE PARTS....24

3 SECTION 3 : PARAMETERS BDC-H 24

3.1. HOIST APPLICATION PARAMETERS LIST....24

3.2. PARAMETER DESCRIPTIONS - HOIST 25

3.2.1. CT Ratio....25

3.2.2. Motor current....26

3.2.3. Overload Class 26

3.2.4. Notch 1....27

3.2.5. Notch 2....27

3.2.6. Notch 3....27

3.2.7. Hoist plugging 27

3.2.8. Hoist plugging V....28

3.2.9. Lower plugging V 28

3.2.10. Brake release I 28

3.2.11. Hoist start volt....29

3.2.12. Stop delay 29

3.2.13. Lower plugg out....29

3.2.14. Max stall volts....29

3.2.15. Ph shift on time....30

3.2.16. Ph shift off time....30

3.2.17. Separate Directional Signals....32

3.2.18. Load defaults....33

3.3. TRAVEL APPLICATION PARAMETERS LIST....34

3.4. PARAMETER DESCRIPTIONS – TRAVEL....33

3.4.1. Current Transformer Ratio....33

3.4.2. Current Transformer Enable....33

3.4.3. Motor Current 34
3.4.4. Overload Class 34
3.4.5. Notch Speed 1 35
3.4.6. Notch Speed 2 35
3.4.7. Notch Speed 3 35
3.4.8 Notch Plugging 35
3.4.9 Notch Plugging V 35
3.4.10 Neutral Plugging 36
3.4.11 Neutral Plugging V 36
3.4.12 Brake Plugging V 36
3.4.13. Maximum Stall Voltage 37
3.4.14. Minimum Start Voltage 37
3.4.15. Notch 1; 2 and 3 Acceleration Time 37
3.4.16. Notch 4_Accel Profile 38
3.4.17. Phase Shifter Off Time 38
3.4.18. Notch 4 Delay 38
3.2.19. Separate Directional Signals 39
3.4.20. Load Defaults 40

3.5. Torque Application Parameters List 41

3.6. PARAMETER DESCRIPTIONS – TORQUE 42
3.6.1. Load Defaults 42
3.6.2. Current Transformer Enable 42
3.6.3. Overload Class 43
3.6.4. Current transformer ratio 43
3.6.5. Motor full load current 44
3.6.6. Short Circuit Detection 44
3.6.7. Start Volts 45
3.6.8. Notch Voltages 45
3.6.9. Notch delays 46
3.6.10. Plugging Voltages 47
3.6.11. 1st Rotor 47
3.6.12. 2nd Rotor 48

4. SECTION 4 : INSTALLATION 49

4.1. GENERAL INSTALLATION 49

4.2. MECHANICAL INSTALLATION 49
4.2.1. General 49

4.2.2. Mounting Instructions 49
4.2.3. Tools and Special Equipment 50
4.2.4. Mounting Arrangements 51
4.2.5. Mounting Procedure 53
4.3. ELECTRICAL INSTALLATION 54
4.3.1. General 54
4.3.2. Electrical Connection Instructions 55
4.3.3. Tools and Special Equipment. 59
4.4. INSTALLATION DIAGRAMS 60
4.4.1. Digital Inputs – Main Board 60
4.4.2. Digital Inputs – Connectors on the Control Panel 61
4.4.3. Relay Outputs – Connectors on the Main Board 61
4.4.4. Triac Outputs – Control Panel Board 62
4.4.5. Motor Current Inputs 63

5. SECTION 5 : COMMISSIONING 64

5.1 GENERAL 64
5.2 PREPARATION 64
5.3. COMMISSIONING PROCEDURES 65
5.4. HOIST OPERATION 70
5.4.1. Hoisting 70
5.4.2. Lowering With an Overhauling Load 70
5.4.3. Regeneration 70
5.4.4. Lowering With a Light Load 70
5.5. TRAVEL OPERATIONS 71
5.5.1. Travel In All Directions 71

6 SECTION 6 : OPERATION OF CONTROL PANEL 72

6.1. GENERAL 72
6.2. SUPPLEMENTARY DISPLAY PAGES "SCROLL MENU" 74
6.2.1. Parameters 74
6.2.2. Set Time 75
6.2.3. Fault History 75
6.3. KEY PAD PUSH BUTTONS 75
6.4. CONTROL PANEL OPERATION 76

6.5. PARAMETER LISTS PAGE....77
6.5.1. Accessing the Parameters Page....77
6.6. SET TIME PAGE....78
6.7. FAULT HISTORY....79
6.8. POSSIBLE CAUSES OF FAILURE ON HOIST SYSTEMS:....84
6.8.1 LOSS OF ROTOR FEEDBACK....84
6.8.2 CURRENT FEEDBACK LOSS (All 3 phases)....87
6.8.3 Single Phase Current Loss....89
6.8.4 Current unbalance....90
6.8.5 Rotor feedback and Current feedback loss....91
6.8.6 Overcurrent....92
6.8.7 Not in Neutral....92
6.8.8 Joystick error....93
6.8.9 Motor stall....93
6.8.10 Stack over-temperature....94
6.8.11 Hoist Loss of torque....94
6.8.12 Lower overspeed....94
6.8.13 Input phases....94
6.8.14 Brake release....95
6.8.15 Drive level....95
6.8.16 Power On test....95
6.8.17 Code faults....96
6.8.18 Healthy....97
6.9 POSSIBLE CAUSES OF FAILURE ON TRAVEL SYSTEMS:....97
6.9.1 LOSS OF ROTOR FEEDBACK....98
6.9.2 CURRENT FEEDBACK LOSS (All 3 phases) (Applicable only if CTs enable = Yes)....100
6.9.3 Single Phase Current Loss (Applicable only if CT enable = Yes)....102
6.9.4 Current unbalance (Available only when CTs enable = Yes)....103
6.9.5 Rotor feedback and Current feedback loss (Available only when CTs enable = Yes)....105
6.9.6 Overcurrent....105
6.9.7 Not in Neutral....106
6.9.8 Joystick error....106
6.9.9 Motor stall....106
6.9.10 Stack over-temperature....106
6.9.11 Hoist Loss of torque....106
6.9.12 Lower overspeed....106
6.9.13 Input phases....106

6.9.14 Brake release 106
6.9.15 Drive level 106
6.9.16 Power On test 106
6.9.17 Code faults 107
6.9.18 Healthy 107

7 SECTION 7 : MAINTENANCE 108

7.1. GENERAL 108

7.2 PREVENTATIVE MAINTENANCE 108
7.2.1 Brakes 108
7.2.2 Ultimate Limit Switch 109

7.3 CRANE MAINTENANCE CHECK LIST FOR THYROMAT SYSTEM CONTROL 109

7.4. SPARE PARTS LIST 113

8 SECTION 8 : SHIPPING AND STORAGE 116

8.1. GENERAL 116
8.1.1. Shipping 116
8.1.2. Storage 116

9 SECTION 9 : ACRONYMS AND ABBREVIATIONS 117

9.1. GENERAL 117

1 GENERAL

1.1 CONTROL SYSTEM

The THYROMAT range is used to control crane hoist and travel motions using slip-ring motors. The controller is well suited to heavy duty and continuous operations in extreme environments. THYROMAT digital crane control delivers leading thyristor control technology to a new generation of crane drives. It is the natural successor to MH Automation's very successful THYROMAT analogue crane drive.

Solid-state electronics allows a compact design with enhanced reliability. Self-monitoring further improves system safety and reliability. Software features and all hardware components are engineered to meet the requirements for both new and existing cranes. THYROMAT digital crane control makes crane operation simple, safe, precise and consequently more productive.

MH Automation's experience and know-how of crane applications combined with digital technology and thousands of man-hours of engineering and design has resulted in a unique, robust and reliable product. Designed specifically to operate in the tough environments of steelworks THYROMAT digital is a robust crane controller suitable for all types of steelworks cranes. Table 1-1 details the special features of the THYROMAT.

Table 1-1 : Special Features.

SPECIAL FEATURES	
FEATURE	**ADVANTAGES**

Excellent reliability	• Increased production
	• Low maintenance
	  ○ Reduced operation costs
	• Robust compact mechanical construction
	  ○ Resistant to vibration
	• Operates in extreme ambient conditions
	  ○ Rated for continuous duty at 60°C
	  ○ Control box sealed from dusty environment
	  ○ Control cards protected with silicon coating

High degree of safety	• Torque proving before operation commences • Self diagnostics ○ Built in watchdog timers • Built in electronic controller in neutral checking • Opto isolation of inputs

User friendly	• Control panel
	  ○ Keyboard to enter parameters
	  ○ Display to show real time motor information
	  ○ Display faults and history
	  ▪ Reduced down time
	  ▪ Enables preventative maintenance

SPECIAL FEATURES	
FEATURE	**ADVANTAGES**

Excellent control	• Load independent control
	  ○ Excellent repeatable placing of end load
	  ○ Safer working environment for personnel
	• Smooth steady control
	  ○ Safe efficient load handling
	  ○ Gearbox and couplings not subjected to excessive stress
	  ○ Reduced current peaks
	  ▪ Slip-ring maintenance reduced
	  ▪ Motor life extended
	• Safe brake control
	  ○ Torque proving before brake is opened
	  ○ Brake is used only as a parking brake and in emergency conditions
	  ○ No more continual replacing of brake parts.

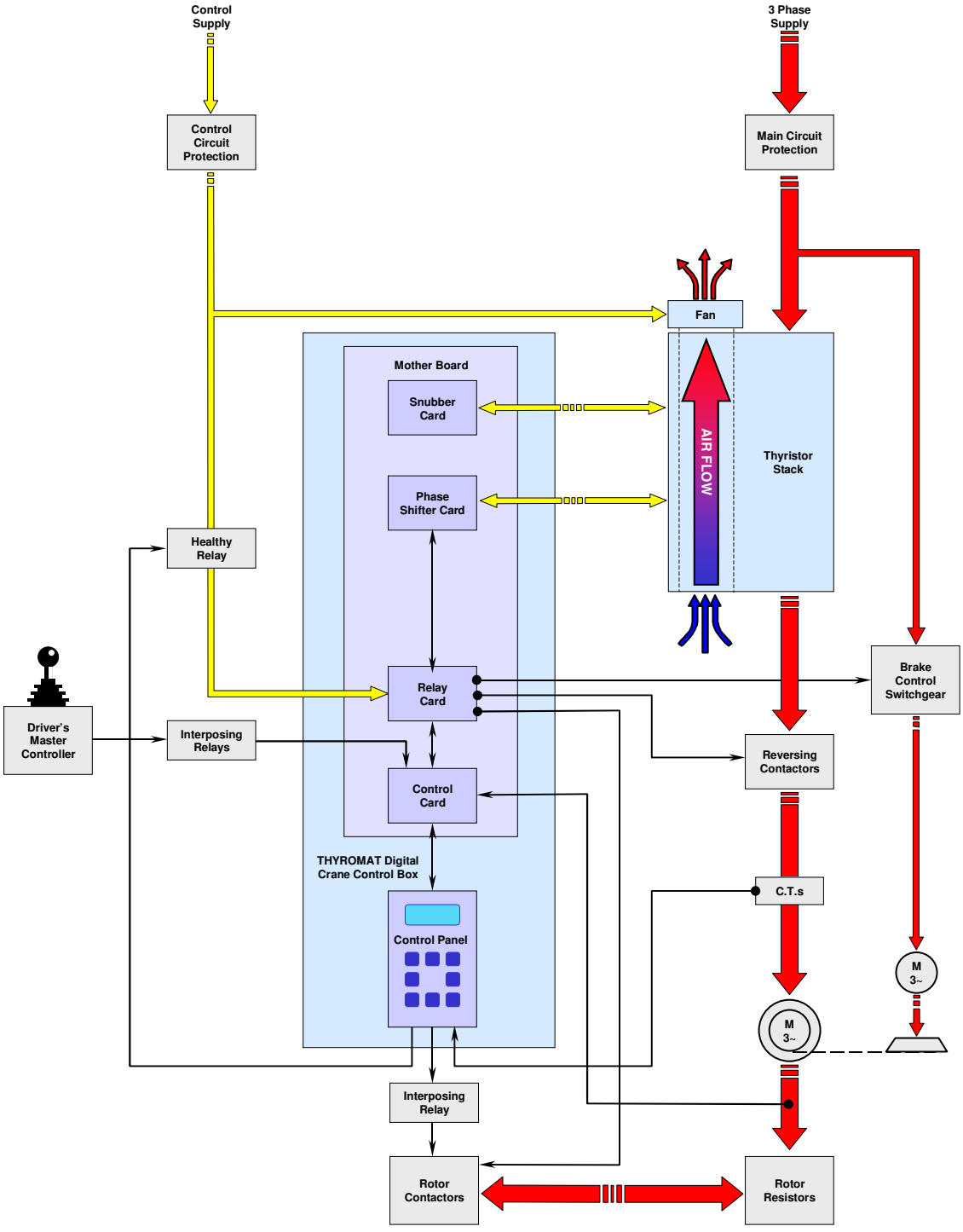
Rotor feedback speed measurement	• No tacho generator or pulse encoder required
	  ○ No mechanical modifications needed on motor shaft
	  ○ No additional installation costs, labour and equipment
	  ○ Automatic motor condition monitoring
	  ▪ Early warning of motor failure
	  ○ No maintenance of a tacho required
	  ○ No need for small control wires in cable loop system
	  ○ Simplifies the control system

Reversing contactors	• Reversing contactors are used to change torque direction on motor
	  ○ Improved reliability as compared with static bridge system
	• Contactors are switched during zero current conditions
	  ○ No maintenance on contact tips
	  ○ Contactor life extended

Simplicity	• Simple quick installation
	• Training easy to perform
	• Understood easily by maintenance staff
	  ○ Faults on crane easy to find
	  ▪ Loss of production eliminated
	  ○ Rapid acceptance by maintenance staff

Large range	• Covers complete crane range
	  ○ Control system the same for any size motor
	  ○ Ideal for single motor use with emergency operation requirement.

1.1.1 Basic System Diagram



The system's simplicity is illustrated in the Basic System Diagram (refer to Figure 1-1). This diagram is applicable to both hoist and travel operations.

Figure 1-1 : Basic System Operational Diagram

1.1.2 THYROMAT Components Identification

The following illustration details the components identification (refer to Figure 1-2). This diagram is applicable to both hoist and travel motions.

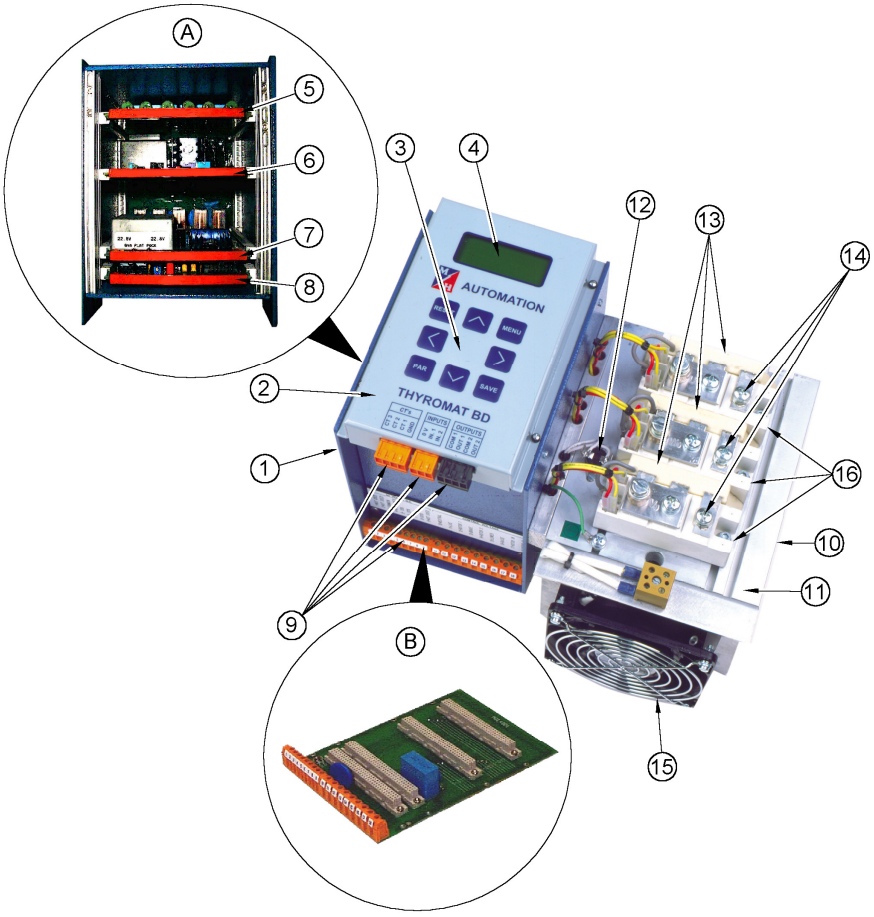


Figure 1-2 : THYROMAT Components

1. Control box
2. Control panel
3. Keypad
4. Display
5. Snubber card
6. Phase shifter card
7. Relay card
8. Control card

A Interior of control box
B Mother board

9. Control connectors on control panel
10. Thyristor stack
11. Heat sink
12. Temperature switch
13. MOV
14. Supply connections
15. Fan
16. Thyristor pack

2 SECTION 2 : SYSTEM DESIGN

2.1. GENERAL

The following paragraphs detail the selection of the Thyromat and associated equipment as well as the details for the operation of the THYROMAT.

2.2. THYROMAT BD DIGITAL CRANE CONTROLLER RANGE

Table 2-1 details the THYROMAT range.

Table 2-1 : THYROMAT Range

THYROMAT Abbreviated Code	Ampere Rating at 60°C	Mechanical Size	Dimensions W x H x D in mm	Weight (Approx.)
THYROMAT – BD 25	25 A	M100	237 x 180 x 202	6 kg
THYROMAT – BD 30	30 A	M100	237 x 180 x 202	6 kg
THYROMAT – BD 60	60 A	M100	237 x 180 x 202	6 kg
THYROMAT – BD 100	100 A	M150	296 x 180 x 225	10 kg
THYROMAT – BD 150	150 A	M150	296 x 180 x 225	10 kg
THYROMAT – BD 200	200 A	M350	293 x 450 x 250	21 kg
THYROMAT – BD 350	350 A	M350	293 x 450 x 250	23 kg
THYROMAT – BD 400	400 A	M500	515 x 525 x 355	41 kg
THYROMAT – BD 500	500 A	M1000	515 x 665 x 355	52 kg
THYROMAT – BD 700	700 A	M1000	515 x 665 x 355	52 kg
THYROMAT – BD 1000	1000 A	M1000	515 x 665 x 355	52 kg
THYROMAT – BD 1200	1200 A	M2000	789 x 855 x 443	100 kg
THYROMAT – BD 1500	1500 A	M2000	789 x 855 x 443	103 kg
THYROMAT – BD 2000	2000 A	M2000	789 x 855 x 443	107 kg
THYROMAT – BD 2500	2500 A	M2500	ON REQUEST	ON REQUEST

The product range is defined as detailed in Table 2-2.

Table 2-2 : Product Range Definition

Series		Current	Supply Voltage	Control Voltage	Explanation
Type	Motion				
BX	X	025	380	X	
					B - Alternating current (ac) applications BD - Digital applications
					H - Hoist applications T - Travel applications
					025 A 200 A 1 000 A 030 A 350 A 1 200 A 060 A 400 A 1 500 A 100 A 500 A 2 000 A 150 A 700 A 2 500 A
					380 volts 415 volts 525 volts
					A - 110 volts B - 220 volts

For example a product with the designated code:

BDH 025 380 B

This would be defined as a unit having the following characteristics:

- **B** Alternating current (ac)
- **D** Digital
- **H** Hoist
- **025** 25 Ampere supply current
- **380** 380 Volts supply voltage
- **B** 220 Volts control voltage

2.3. PROTECTION

Table 2-3 lists the protection specifications for the THYROMAT.

Table 2-3 : THYROMAT Protection

Item	Specification
Control enclosure	IP51
Thyristor stack	IP00

2.4. THYROMAT - BD DIGITAL CRANE CONTROLLER SELECTION

The selection of the THYROMAT for specific mechanical power requirements depends on the base stator current rating on of the slip-ring motor to be used. In the event that the base stator current ratings are not known then it is suggested that the same ratings S_4 or S_5 for crane duty slip-ring motors be used.

Perform the following steps to calculate the mechanical power

Step 1. Calculate the mechanical power that will be generated by the motor using the speed, load and efficiency of the motion.

Step 2. If this data is not available use the electrical power for the specific duty.

Step 3. Obtain the stator current for the specific power selected

Step 4. Refer to the table and select the THYROMAT.

The selection of the THYROMAT has been divided into two operational categories for both hoist and travel namely, standard duty and severe duty.

The following paragraphs define standard and severe duty applications:

2.4.1 Standard Duty

The following defines standard duty:-

Characteristics

- Rated starting class - 150 starts per hour.
- Cyclic duration factor - 40%
- Max. Ambient Temperature - 40ºC
- Altitude above sea level - < 1 500 meters

The typical standard duty applications are as for BS 466:1984 cranes with a group mechanism in M3 and M4, the following lists typical standard duty applications:-

Applications

- Power station cranes.
- Light workshop cranes.
- Light stores duty cranes.
- Light general load handling cranes

2.4.2 Severe Duty (Based on 40% of nominal load permanently on hook).

The following lists the severe duty parameters:-

Characteristics

- Rated starting class - 150 to 600 starts per hour.
- Cyclic duration factor - 40% or 60%
- Max. Ambient Temperature - 60ºC
- Altitude above sea level - < 1 500 meters

The typical severe duty applications are as for BS 466:1984 cranes with a group mechanism in M5 to M8 heavy duty, workshop, warehouse and general hook service. The following lists typical severe duty applications:-

Applications

- Crane for grabbing work.
- Ladle crane for foundry work.
- Magnet crane for stockyard work.
- Magnet crane for scrap yard work.
- Process crane.
- Shipyard crane.
- Ladle crane.
- Pig/scrap breaking crane.
- Ingot stripper.
- Stocking pit mould-handling crane.
- Vertical ingot charger.
- Furnace charging crane.
- Forging crane.
- Heavy mill service crane.
- Heavy-duty service and maintenance crane.

Table 2-4 details the selection of the **maximum stator current** ratings for both hoist and travel in standard and severe duty applications of the various THYROMAT units.

Table 2-4 : Maximum Motor Stator Current Ratings

THYROMAT - BD		Stator Current			
Unit Sizes	Continuos Current Ratings at 60°C	Hoist		Travel	
		Standard Duty	Severe Duty	Standard Duty	Severe Duty
M100	25 A	20.5 A	17.5 A	22.5 A	20.5 A
	30 A	25 A	21 A	27 A	25 A
	60 A	50 A	43A	55 A	50 A
M150	100 A	83 A	71 A	90 A	83 A
	150 A	125 A	107 A	136 A	125 A
M350	200 A	166 A	143 A	181 A	166 A
	350 A	291 A	250 A	318 A	291 A
M500	400 A	333 A	285 A	363 A	333 A
M1000	500 A	416 A	357 A	454 A	416 A
	700 A	583 A	500 A	636 A	583 A
	1000 A	833 A	714 A	909 A	833 A
M2000	1200 A	1 000 A	857 A	1 090 A	1 000 A
	1500 A	1 250 A	1 071 A	1 363 A	1 250 A
	2000 A	1 666 A	1 428 A	1 818 A	1 666 A
M2500	2500 A	2 080 A	1 780 A	2 270 A	2 080 A

2.5. PRINCIPLE OF OPERATION

The THYROMAT is connected in series with the stator supply voltage.

The control unit varies the stator voltage of the slip-ring motor by adjusting the firing angle of the inversely connected (parallel) thyristors in each of the three phases. The motor torque is proportional to the square of the stator voltage ($T \alpha V^2$ - where T is the motor torque and V is the stator voltage). The speed of the motor is measured by the frequency of the rotor. Reversing the direction of motor rotation is achieved by switching externally mounted reversing contactors at zero current.

Before operation can commence, safety circuits monitor the motor for incorrect phase rotation, severe phase differences or unbalance and low three-phase voltage supply and will only allow operation in the event that all the conditions are correct. Electrical interlocking is provided to make sure that the master controller is returned to the zero position after a power or phase loss after which the system will have to be restarted before operation can commence.

Mechanical stresses to the motor and gearbox are minimised by ramping all the supplied voltages this, in turn, provides constant acceleration and deceleration.

There are three independent slow speeds in both directions. Selection of full speed causes the motor to ramp up (accelerate) to full speed. The two acceleration contactors are activated at 50% speed (25 Hz) and 75% speed (12,5 Hz) respectively and the result is a smooth acceleration up to full speed. The peak switching current during the acceleration cycle is limited to approximately twice that of the full load current.

2.5.1. Control Box

CAUTIONS

1. **CARE MUST BE TAKEN WHEN INSERTING CARDS INTO THE MOTHERBOARD NOT TO BEND THE CONNECTING PINS**

2. **DO NOT TOUCH ANY OF THE COMPONENTS ON THE CIRCUIT BOARDS, THEY ARE VOLTAGE SENSITIVE AND MAY BE DAMAGED / DESTROYED.**

The control box contains the control cards necessary for the control of the motion and thyristor firing circuitry. There are four individual cards that are common to the complete range. The cards are contained in a box that has an IP51 rating. This keeps out the harmful dust ever present in steelworks environments. The Control panel secures the cards in their sockets and minimises the effects of vibration.

Each electronic card is covered with a conformal protective coating. This coating has the following benefits :-

- Increased isolation between points at different potentials
- Improved mechanical strength of components further resisting vibration
- Further protection to card from metallic dust and humidity.

2.5.2. Control Card

The control card consists of a microprocessor that interfaces with the process input and outputs. The microprocessor integrates on-chip program memory, data memory (RAM) and serial communication. Also on the card is the serial EEPROM, keypad and display driver communication interface.

The rotor frequency is evaluated on this card using digital signal processing. This gives the motors actual speed. Inputs are optically isolated achieving high integrity of the control system.

2.5.3. Relay Card

This card contains the five relays for switching the external contactors and the power supply for these relays.

2.5.4. Phase Shifter Card

This card determines the trigger delay angle for the firing of the thyristors as well as circuitry for disabling the unit in the event of incorrect phase rotation, severe phase imbalance or low supply voltage. The 10 Volt control voltage is derived from the main supply voltage within this card.

The thyristor firing circuitry uses a phase locked loop control circuit and is therefore not sensitive to incoming mains disturbances.

The thyristor trigger module incorporates a unique dynamic time/amplitude transient clipping circuit.

2.5.5. Snubber Card

This card protects the thyristors from supply voltage transients.

Together with the metal oxide varistors (MOV's) mounted on the thyristors, the Snubber network card provides a high degree of protection.

NOTE

The Snubber card is not used on Thyromat units bigger than 1000A, the Snubber network is then installed across the Thyristors on the stack.

2.5.6. Control Panel

The control panel is the man machine interface (MMI) of the Thyromat unit.

It serves as a window for monitoring various motor variables such as stator currents, motor speed, drive status, etc…

It is used to enter the user parameters which makes the Thyromat specific to the application.

2.6. CONTROL SYSTEM SPECIFICATIONS

Table 2-5 details the THYROMAT controller Specifications.

Table 2-5 : THYROMAT Controller Specifications

TECHNICAL DATA		
CONTROLLER DATA		
Mains supply to THYROMAT	Input voltage U - V – W	380 V – 415 V 3 phase 50 Hz 525 V - 550 V 3 phase 50 Hz
	Supply variations	+10% - 15%
	Trip level of THYROMAT	380 V - 415 V range < 266 V 525 V - 550 V range < 367 V
Output supply to motor	Uo - Vo - Wo	Variable up to mains RMS level
Control supply	Terminals 10 - 11	110 V - Single phase 50 Hz 220 V - Single phase 50 Hz Other voltages (on request)
	Supply variations	+10% - 15%
Digital inputs Control voltage	Generated by the THYROMAT internal regulated supply circuit	10 V DC max 5 mA per input
Outputs	Main board 110 V or 220 Vac supply	5 x Relay outputs with combined common max. rating 220 Vac 16 A max . AC11. Continuous rating 2 A AC14 as per IEC 947-5
	Control panel	2 x separate triac outputs 600 VAC 100mA continuous max switching current = 2 A (Not used in crane applications)
Current inputs	3 Phase stator current monitoring	Rated at 1 A continuous max. peak current = 3 A
Ambient operating temperature	-10℃ (no frost) to +60℃ at rated current	
Storage temperature	-40℃ to + 60℃	
Relative humidity	<95%, no condensation allowed	
Air quality - Chemical vapours - Mechanical particles	IEC 721 - 3 - 3 unit in operation, class 3C2 IEC 721 -3 - 3 unit in operation, class 352	

TECHNICAL DATA	
CONTROLLER DATA	
Altitude	Max. 1500 m at continuous rated current Over 1500 m reduce rating by 1% for each 100 m, absolute maximum altitude 3000 m
Vibration IEC 721 - 3 - 3	Operating: Max displacement amplitude 3 mm at 2 - 9 Hz Max. acceleration amplitude 0,5 G at 9 –200 Hz
Shock IEC 68 - 2 - 27	Operation: max 8G, 11 ms Storage and shipping: max 15 G, 11 ms inside the manufacturers package
Enclosure	Control box: IP51 Power stack frames M100 to M2000: IP00
Protective functions	Over current protection: set at 4 x unit rating for a period longer than 2,5 seconds Input phases rotation Input phases under voltage: < 0,7 Un Input phases single phasing Output phases unbalanced: > 50% unbalance Unit temperature: stack temperature > 95°C Motor overload protection: This feature is not yet implemented Loss of rotor frequency feedback Loss of torque detection
Control method	Phase angle control; 3 phase, 6 thyristors connected in line with motor stator in anti-parallel configuration
Operating frequency	50 Hz ± 1%
Braking torque	Varies with rotor resistors values used, standard max. 2,5 x Tn. Units may be designed for greater ratings. Consult MH Automation for further details
Unit power dissipation	Control box: max. 40 W Thyristor stack: Approximately 3,8 W/A of motor actual running current at 60% C.D.F

2.7. THYROMAT - BD DIGITAL CRANE CONTROLLER ENCLOSURES

The details listed in this paragraph are based on a complete THYROMAT installation. This includes items such as the drive, contactors, relays, motor protection unit and other auxiliary components/equipment. The listed enclosure sizes suggest the minimum requirement and should be used as a guideline only. The environmental conditions used as a model for the enclosure sizes is based on the following assumptions:

- Ambient temperature - 40°C
- Maximum internal temperature of enclosure - 60°C
- Type of plant - Ladle handling crane
- Location - Indoors
- Degree of protection - IP54

Table 2-6 details the THYROMAT Enclosures.

Table 2-6 : THYROMAT Enclosures

Enclosure Size and Ventilation Table						
THYROMAT MECHANICAL Sizes	**THYROMAT Current Ratings**	**Total Heat Dissipation of Switchgear**	**Height (mm)**	**Length (mm)**	**Width (mm)**	**Remarks**
M100	**25 A**	480 W	1400	800	400	No forced ventilation required.
	30 A	480 W	1400	800	400	
	60 A	480 W	1400	800	400	
M150	**100 A**	480 W	1400	800	400	
	150 A	720 W	1400	800	400	
M350	**200 A**	960 W	1400	1400	400	
	350 A	1 600 W	1400	1800	400	Forced ventilation with filters recommended.
M500	**400 A**	1 830 W	1400	1800	400	
M1000	**500 A**	2 280 W	1800	1400	500	Forced ventilation with filter recommended or open chassis plate installed inside crane girders where possible.
	700 A	3 200 W	1800	1400	500	
	1 000 A	4 580 W	1800	1600	500	
M2000	**1 200 A**	5 430 W	1800	1800	500	
	1 500 A	6 680 W	1800	1800	500	
	2 000 A	8 800 W	1800	2100	500	
M2500	**2 500 A**	10 759 W	2100	2100	500	

2.8. SELECTION OF RESISTORS

The design and selection of the rotor resistor is detailed in the following paragraphs. It is assumed that the designer has a good working knowledge of crane mechanical power calculations.

Step 1

Determine the electrical power ($\mathbf{P_e}$) of the motor for the duty the crane will operate from motor manufacturers data tables.

Step 2

Calculate the mechanical power (P_m) required by the motor. Use values of speed, load and efficiency of the motion.

Step 3

Obtain the rotor current (R_A) at determined $\mathbf{P_e}$ from motor manufacturers data tables.

Step 4

Calculate new R^1_A

$R^1_A = R_A \times \mathbf{P_m} / \mathbf{P_e}$

Step 5

Calculate the motors rotor resistance ($\mathbf{K_{100}}$) that will give 100% rated torque at start. Obtain the motors open circuit rotor voltage ($\mathbf{R_V}$) from motor tables

$K_{100} = \mathbf{R_V}/(\sqrt{\mathbf{3}} \times R^1_A)$

Step 6

Determine the resistor values required from the selection table (refer to table 2-7). Figure 2-1 illustrates the resistor configuration.

$R1_{TOT} = R1$

$R2_{TOT} = R1 + R2$

$R3_{TOT} = R1 + R2 + R3$

$R4_{TOT} = R1 + R2 + R3 + R4$

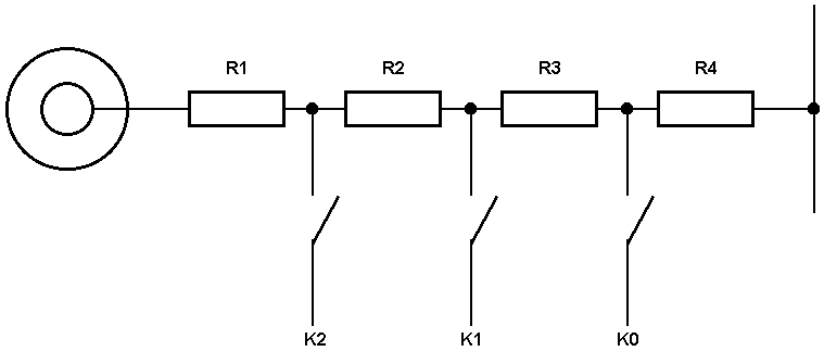


Figure 2-1 : Resistor Configuration

Table 2-7 :-Resistor Values

Motion	Ohms	% of K			
		$R1_{TOT}$	$R2_{TOT}$	$R3_{TOT}$	$R4_{TOT}$
Hoists, all motions with adequate torque margins	0.36 K_{100}	9	18	36	
Hoists, large motors and motors with low torque margins	0.65 K_{100}	9	18	36	65
Travels	0.3 K_{100}	30	-	-	-

It is a requirement that a crane has the ability to lift 125% of the nominal load, this factor must be taken into account during commissioning process only.

When selecting the current carrying capacities of the resistor grids and sections, the following factors need to be considered:

- Ambient temperature
- Duty cycle
- Slow speed operations

2.9. SELECTION OF MAINS CIRCUIT BREAKERS

It is critical that the selection of the mains circuit breaker for the THYROMAT must be able to protect the THYROMAT unit against most current surges.

It is **strongly recommended** that a circuit breaker type such as manufactured by Merlin Gerin (part number NS...N-STR2.E or similar) is used. The suggested circuit breaker (STR electronic trip unit) is one of the most flexible circuit breaker types with regards to protection settings in both the low and high short-circuit protection ranges. The circuit breaker also has reflex tripping which is triggered by the energy dissipated within the device when a short-circuit condition is experienced.

The correct selection of the circuit breaker will depend on the thyristor stack current rating and the slip-ring motors nominal current rating. Table 2-8 lists the circuit breaker selection details for the various thyristor stacks, it is possible to downsize the selected circuit breaker by matching it with current rating of the individual slip-ring motor.

Table 2-8 : Circuit Breaker Selection

THYROMAT Mechanical Size	THYROMAT Current Ratings	Circuit Breaker	
		Frame	Trip Unit
M100	25 A	NS 100_	STR 22SE 40A
	30 A	NS 100_	STR 22SE 40A
	60 A	NS 100_	STR 22SE 100A
M150	100 A	NS 100_	STR 22SE 100A
	150 A	NS 160_	STR 22SE 160A
M350	200 A	NS 160_	STR 22SE 160A
		NS 250_	STR 22SE 160A
	350 A	NS 250_	STR 22SE 250A
		NS 400_	STR 23SE 400A
M500	400 A	NS 400_	STR 23SE 400A
M1000	500 A	NS 400_	STR 23SE 400A
		NS 630_	STR 23SE 630A
	700 A	NS 630_	STR 23SE 630A
	1000 A	NS800_	Micrologic 2.0
M2000	1200 A	NS1000_	Micrologic 2.0
	1500 A	NS1250_	Micrologic 2.0
	2000 A	NS1600_	Micrologic 2.0
M2500	2500 A	NS2000_	Micrologic 2.0

NOTE

1. **The thermal settings are according to the slip-ring motor details or in the event that these details are not available, use the stator current equivalent for the applicable mechanical power requirements.**

2. **The short circuit protection settings for the slip-ring motor are usually 3 times the motor stator current.**

2.10. SELECTION OF INTERPOSING INPUT RELAYS

Every Thyromat installation makes use of input signals interposing relays. This is required to ensure that the **10V DC Thyromat input signals are confined to the electrical panel. Such 10V DC remains within the electrical panel environment.**

External switching of directional as well as speed notch signals may then be supplied by the crane control supply, which will control these interposing relays.

It is strongly recommended that the interposing relays have the following characteristics for optimum system performance.

- They must be hermetically sealed
  This is a requirement due to most cranes operating under severe environmental conditions that could include dust and/or corrosive gases
- They must have a minimum contact burden of 5 mA / V

2.11. SELECTION OF INTERPOSING OUTPUT RELAYS

Where applicable, use interposing contactors between the relay outputs of the THYROMAT and the stator / rotor contactors.

Contactors can be used as single units or where necessary may be used in parallel. The rating of the continuous supply current from the relay card is at a maximum of 2A, therefore the maximum continuous allowable VA rating is 220 VA at 110 V and 440 VA at 220 Vac. This means that the consumption of each contactor when closed may not exceed 50 VA (110 V system) or 100 VA (220 V system), leaving a small margin to feed the brake contactor, which uses approximately ≤ 20 VA.

NOTE

In the event that interposing output relays are required then the sum of the pull in and drop out times of both the contactor and interposing output relay should be taken into consideration when setting up the phase shifter ON and OFF time parameters. This is to ensure that the switching under zero current remains true.

Example:

Drop out

Interposing relay:	LC1 – D0910	drop out time	12 ms
Associated contactor:	LC1 - F185	drop out time	50 ms
	Combined drop out time	=	72 ms

Pull in

Interposing relay:	LC1 – D0910	pull in time	8 ms
Associated contactor:	LC1 - F185	pull in time	30 ms

Combined pull in time = 38 ms

2.12. SELECTION OF CABLES

The following paragraphs detail the selection of power supply and control power cables.

2.12.1. Power Supply Cables

The specifications of the power supply cables must be calculated according to recognised standards (e.g. BS 7671) and the cable manufacturer's recommendations.

Several factors need to be taken into consideration when selecting the correct power supply cables such as the ambient operating temperatures, the cyclic duration factor of the application and the cable length. The voltage drop across the cable under acceleration and reverse plugging conditions caused by the higher motor currents..

The selection of the cable should take into account the main circuit breaker to be used so that the efficient protection of the thyristor stack is not compromised, therefore it is advisable to select the cables conservatively.

Armoured PVC insulated cables are normally used along the bridge and crab, and flexible PVC or rubber-insulated cables are used on festoon systems. The selection of cable selection also largely depends on the environmental conditions that the crane will operate in.

2.12.2 Control Power Cables

The THYROMAT uses interposing relays to allow the use of an external control voltage of 110 VAC or 220 VAC, which is not sensitive to external noise interference. Therefore the use of standard armoured control power cables is sufficient, the cables should have a minimum diameter of 1,5 mm², preferably a cable diameter of 2,5 mm² should be used for improved mechanical strength.

2.13. SELECTION OF STATOR REVERSING CONTACTORS

It is only necessary to rate the contactors for thermal current (Ith) because the THYROMAT switches the reversing contactors at zero current and voltage. The thermal current selection depends on the type of application (i.e. Standard or Severe Crane Duties).

For Standard Duty applications, at least 1,1 x In (nominal current) at AC1 rating is recommended.

For severe duty applications, at least 1,4 x In (nominal current) at AC1 rating is recommended.

Example:

A slip-ring motor is to be used in a severe application, the motor has a mechanical rating of 100 A.

Therefore:- AC1 = 1,4 x In
= 1,4 x 100
= 140 Ampere

According to information provided by the manufacturer the selected contactors would be LC1-F115 which has a rating of 200 A at AC1 or 115 A at AC3.

2.13.1. Contactor Switching Times

The THYROMAT is designed to be able to switch contactors at zero current, parameters are provided to enable the user to set the correct switching times so that, during contactors change over arcing is avoided.

It is imperative that the users makes themselves familiar with the contactors switching times relevant to the installation.

2.13.2. Contactors Drop Out Times

During directional contactors change over the THYROMAT provides a delay between the time that the thyristors are turned off untill the time that the contactor is de-energised. This will ensure that there is no current flowing in the circuit at the instant that the contactor is required to drop out. This process increases the electrical life of the contactor and allows the use of contactors with AC1 ratings as opposed to contactors with AC3. Refer to Phase Shifter ON and OFF time parameters for further details.

2.14. SELECTION OF CURRENT TRANSFORMERS

When selecting the current transformer (C.T.) ratio the following formula gives the minimum ratio that should be considered:

C.T. rating > 60% of motor full load current

Example:

Motor full load current = 125A
Therefore the C.T ratio > 125/0,6
= 208,3A

The closest C.T. ratio available in the Thyromat BD is 300:1 A.

The available C.T. ratios are:

050:1	800:1
100:1	1000:1
200:1	1200:1
300:1	1500:1
400:1	2000:1
500:1	2500:1
600:1	3000:1

Note

CT's are required for all hoist applications and optional for travels. All CT's should have a VA rating of at least 5 VA

2.15. SELECTION OF ROTOR CONTACTORS

With Thyromat control rotor contactors are mainly used in Hoist applications.

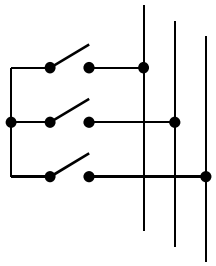
When rotor contactors switch ON, the current raises, due to a shift from a greater slip resistor to a smaller slip resistor. The current peaks are limited to a value between 1,5 and 2,5 times that of the rotor rated current under full load conditions.

The rotor contactors will switch off under zero current conditions provided that the switching times of these contactors are faster or at least equal to the stator contactors switching times. In the event that the switching times are longer the relevant parameters for phase shifter ON and OFF time delays have to be adjusted accordingly.

There are four basic configurations used to connect the rotor contactors, the most popular configurations used are 'Delta' and 'Star' configurations and although not as popular, 'V' and 'W' configurations are sometimes also used. In the interests of promoting reliability, MH Automation has a conservative approach to the selection of the contactors and recommends that the continuous rating of the contactors are used rather than intermediate duty which is used for the intermediate rotor contactors.

The formula used to select the correct rotor contactors for the applicable connection configurations are listed in the following paragraphs:-

2.15.1. Star Connections



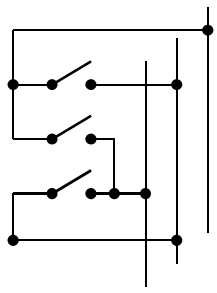
Contactor **thermal current (Ith)** = Motor Rotor Current

Example: Motor Rotor Current = **100 A**

Contactor selected ≥ **100 A Ith**

Ith = **AC1** contactor rating

2.15.2. Delta Connections



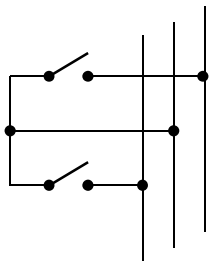
Contactor **Ith** = $\frac{\text{Motor Rotor current}}{1.4}$

Example: Motor Rotor Current = **100 A**

Contactor selected ≥ $\frac{\mathbf{100}}{\mathbf{1.4}}$

= **71.4 A Ith**

2.15.3. V Connections

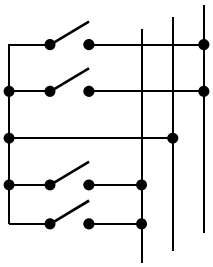


Contactor **Ith** = Motor Rotor Current

Example: Motor Rotor Current = **100 A**

Contactor selected ≥ **100 A Ith**

2.15.4. W Connections



Contactor **Ith** = $\frac{\text{Motor Rotor current}}{1.6}$

Example: Motor Rotor Current = **100 A**

Contactor selected ≥ $\frac{\mathbf{100}}{\mathbf{1.6}}$

= **62.5 A Ith**

2.16. MOTOR THERMAL PROTECTION UNIT - **This feature is not yet implemented**

The THYROMAT has built in motor thermal protection for Class 2 and Class 5 applications the thermal protection required can be selected from the keypad.

It is normally accepted to protect slip-ring motors with a Class 5 I^2t temperature curve. In severe duty applications where high ambient temperatures exist or the motor is exposed to heat radiation, it is recommended that a Class 2 temperature curve is used and the motor power (kW) is rated accordingly so as to ensure a reliable installation.

This method of protection does not monitor the thermal state of the motor accurately, because it can only monitor the current drawn by the motor but does not take in consideration ambient and other essential conditions which may affect the temperature rise of the motor. Therefore it is recommended that wherever possible, PTC thermistor probes and associated relays be used. This will offer additional protection against influencing factors such as, overheating due to a faulty motor ventilation fan, abnormal rise in ambient temperature, abnormal friction in the system due to mechanical or brake failure and unexpected severe duty operations.

In the case of a multi-motor system it is recommended that each motor must have it's own external motor protection unit (MPU) to enable the individual monitoring of each motor. In this event, the size of the

selected MPU should accurately cover the motor's rated current range and must be set according to this current range or to the mechanical power equivalent current rating, which should effectively be lower than that of the rated motor current.

2.17. SELECTION OF SPARE PARTS

CAUTION

Only use spares provided by MH Automation in order to maintain safety and reliability of products, failure to do so will render the warranty of the product null and void.

NOTE

Although the larger (higher current ratings) THYROMAT units are compatible to lower currents, the mounting holes will differ.

MH Automation maintains a stock holding of recommended spares and is able to extend valuable support for all their products. Refer to Section 7 Paragraph 7.3. for further details with regards to the ordering of spares.

3 SECTION 3 : PARAMETERS BDC-H

3.1. HOIST APPLICATION PARAMETERS LIST

Table 3-1 lists the typical parameter settings for hoist version BDC-H Version 10_00 applications.

Table 3-1 : Hoist Parameter List for BDC-H versions

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
1	CT ratio	Current transformers ratio	50:1 to 3000:1	-	50:1A
2	Motor current	Motor nominal current	≤ 60% of CT ratio	Min 2 Amps	10A
3	Overload class	Thermal overload class type	2 or 5	-	5
4	Notch 1	First notch speed	5% to 20%	1%	10%
5	Notch 2	Second notch speed	5% to 40%	1%	20%
6	Notch 3	Third notch speed	5% to 50%	1%	30%
7	Hoist plugging	Enable hoist plugging	Yes or No	-	No
8	Hoist plugging V	Hoist plugging % voltage	20% to 80%	5%	30%
9	Lower plugging V	Lower plugging % voltage	50% to 100%	5%	80%
10	Brake release I	Brake releasing current	0% to 50%	5%	15%
11	Hoist Start Volts	Hoisting min. start volts	30% to 80%	1%	60%
12	Stop delay	Torque hold delay at stop	300 – 1500 ms	50 ms	600 ms
13	Lower plugg out	Lower plugg time out	2000 – 5000 ms	250 ms	3000 ms
14	Max stall volts	Maximum stall voltage	70% to 100%	5%	80%
15	Ph shift on time	Phase shifter on time delay	0 to 140 ms	20 ms	0 ms
16	Ph shift off tim	Phase shifter off time delay	60 to 240 ms	20 ms	100 ms
17	Sep. dir signals	Separate directional signals	Yes or No	-	No
18	Load defaults	Load default parameters	Yes or No	-	No

3.2. PARAMETER DESCRIPTIONS - HOIST

The following paragraphs detail the various hoist parameters.

CAUTION

IF IT IS NECESSARY TO CHANGE PARAMETERS IT IS RECOMMENDED THAT THIS BE DONE IN A CONSERVATIVE MANNER AND ONLY WITH A FULL UNDERSTANDING OF EACH FUNCTION.

3.2.1. CT Ratio

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
1	CT Ratio	CT ratio	50:1 to 3000:1	-	50:1

This parameter selects a current transformer ratio (CT ratio). Only CT ratios from the list below can be used.

THE AVAILABLE CT RATIO'S ARE					
50:1	100:1	200:1	300:1	400:1	500:1
600:1	800:1	1000:1	1200:1	1500:1	2000:1
2500:1	3000:1				

Note

CT's are required for all hoist applications.

3.2.2. Motor current

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
2	Motor current	Motor nominal current	≤ 60% of CT ratio	Minimum 2 A	10A

This parameter sets the motor full load stator current.

The value to be used is the stator current related to the mechanical power for the specific duty.

CAUTION

DO NOT EXCEED THE MOTOR NAMEPLATE VALUE FOR THE APPLICABLE DUTY.

Note

This value should be determined during the design phase. This value is to be used by the thermal model to calculate overload conditions.
This feature is not yet implemented

3.2.3. Overload Class

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
3	Overload class	Thermal overload class type	2 or 5	-	5

This parameter selects the Class of overload that the thermal model uses as a reference.

Class 2:

Trip if stator current exceeds three times motor full load current for a period exceeding 7 sec.

Class 5:

Trip if stator current exceeds three times motor full load current for a period exceeding 17sec.

3.2.4. Notch 1

3.2.5. Notch 2

3.2.6. Notch 3

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
4	Notch 1	Notch 1 speed	5% - 20%	1	10%
5	Notch 2	Notch 2 speed	5% - 40%	1	20%
6	Notch 3	Notch 3 speed	5% - 50%	1	30%

These three parameters set the intermediate slow speeds.

CAUTION

WHEN SPEEDS IN EXCESS OF 30% ARE SELECTED, SPECIAL ROTOR RESISTANCE DESIGN MAY BE NECESSARY.

3.2.7. Hoist plugging

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
7	Hoist plugging	Enable hoist plugging	Yes or No	-	No

Hoist plugging to neutral is load dependent. Under light load or empty hook conditions, the system friction may be insufficient to decelerate the load quickly. When enabled, hoist plugging will detect that during upwards movement, if retardation does not occur at the desirable rate, the system will apply torque in the reverse direction (lowering) to assist with retardation of the upwards movement. The torque applied can be adjusted by enabling (Yes) this parameter and set the voltage level to be applied in the next parameter.

Under load conditions it may not be necessary to assist with retardation due to gravitational force

Therefore the system applies minimum torque, checks the speed of the motor being reduced due to gravity and at the correct speed, applies the mechanical brake.

3.2.8. Hoist plugging V

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
8	Hoist plugging V	Hoist plugging voltage	20% to 80%	5%	30%

This parameter is only active if parameter 7 “Hoist plugging” = Yes (active)..

Hoists with high inertia require assistance during retardation by applying braking torque. The percentage of voltage to be applied controls the amount of braking torque applied to reduce the speed of the drum during hoisting.

This retardation function is only visible when the inertia of the hoist is of such magnitude that the speed error between actual speed and the ramp generator exceeds a certain value when moving the master controller to a slower hoisting speed or to neutral. Practically it means that light loads in hoisting are plugged and most heavy loads are not.

3.2.9. Lower plugging V

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
9	Lower plugging V	Lower plugging voltage	50% to 100%	5%	80%

The lower plugging voltage parameter sets the maximum ceiling % voltage applied during lowering retardation. In the event that this voltage is not sufficient to retard the motor, after an initial period of 750 ms the ceiling is removed and maximum voltage may be applied.

CAUTION

SETTING THIS VALUE TOO HIGH CAN CAUSE HIGH CURRENT PEAKS. SETTING THIS VALUE TOO LOW CAN RESTRICT THE BRAKING TORQUE.

3.2.10. Brake release I

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
10	Brake release I	Brake release current	0% to 50%	5%	15%

This parameter sets the minimum stator current required to allow the brakes to be released.

As a general rule this current value must be equal or greater than the motor magnetizing current. If this current is not known, the no-load current is close enough.

Brake release current = No load current / Motor current x 100

3.2.11. Hoist start volt

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
11	Hoist start volt	Hoisting min. start volts	30% - 80%	1%	60%

This parameter sets up the minimum voltage applied to the motor immediately at start of a hoisting cycle.

When this voltage is reduced the starting up of a hoisting cycle may be smoother when no-load is present but it may allow a slight drop of the load when hoisting, it is advisable to keep it's value between 50% and 60% in most cases.

When this voltage is increased it may cause slight speed overshoot during start-up of no-load operation.

3.2.12. Stop delay

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
12	Stop delay	Torque hold delay at stop	300 – 1500 ms	50 ms	600 ms

This parameter sets the time for zero speed to be held at stop, to allow sufficient time for the mechanical brake to be fully applied.

This eliminates load sagging at stop due to the slow reaction time of the mechanical brake.

3.2.13. Lower plugg out

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
13	Lower plugg out	Lower plugg time out	2000 – 5000 ms	250 ms	3000 ms

The "Lower plugging time out" time, compares to actual motor Lowering retardation profile against the profile set by this parameter. In the event that the actual retardation is going to take longer than the set retardation time a "Lower plug out" trip will occur.

Note: The "Lower plug out" time sets the profile for Lower retardation from 100% to 0% speed.

3.2.14. Max stall volts

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
14	Max stall volts	Maximum stall volts	70% to 100%	5%	80%

This parameter sets the voltage which will remain applied to the motor in the event that the motor is stalled.

This voltage will be applied for a maximum period of 10 seconds, after this time a “Motor Stall” fault will trip the system.

3.2.15. Ph shift on time

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
15	Ph shift on time	Phase shifter on time delay	0 – 140 ms	20 ms	0 ms

During contactor change over, the system disables the phase shifter (firing of the Thyristors) to enable the reversing contactor to change over under zero current conditions.

This parameter allows the phase shifter to be enabled by a further on delay, while the reversing contactors are in the process of changing over.

The total time for the reversing contactors to change over is made of:

Worked out example:

- Reversing contactors LC1-F265
- Contactor **drop out** time with standard LX1-FH coil = 100 to 170 ms
- Contactor **close in** time with standard LX1-FH coil = 40 to 65 ms

The phase shifter on delay time recommended is = 80 ms. Refer to parameter 16 which compliments the settings around reversing contactors change over time.

3.2.16. Ph shift off time

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
16	Ph shift off tim	Phase shifter off time delay	60 – 240 ms	20 ms	100 ms

This parameter complements parameter 15 above.

As described in parameter 15 worked out example, the maximum drop out time for this specific type of contactor is 170 ms.

The recommended phase shifter off delay time is based on the maximum drop out time of the mentioned contactor minus parameter 15 setting value.

(I.e.) Maximum drop out time – parameter 15 = parameter 16.

Example: 170 – 80 = 90 ms. The next available parameter setting is 100 ms (increments of 20 ms).

Note

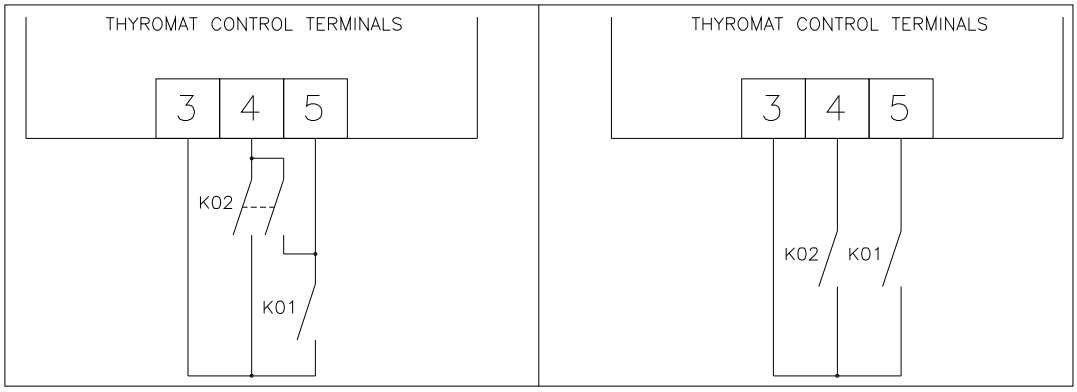
In most cases the default values of both parameters is sufficient for reliable operation. As a general rule deviations from the default values should only be required when contactors with current ratings greater than 225A (AC3) which are

not equipped with special fast acting coils, are used. For further assistance on the correct settings for a specific contactor type, contact MH Automation technical department.

3.2.17. Separate Directional Signals

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
17	Sep. dir signals	Separate directional signals	Yes or No	-	No

This parameter defines the way the input directions are programmed.



Parameter set to “No” Parameter set to “Yes”

Note: In the event that this configuration keeps on giving a “j. error” message out, it indicates that the THYROMAT unit Motherboard is not compatible with these parameters and the parameters need to be set to “No”.

When set as “No”:
This is the way that THYROMAT analogue and early digital units use to select the direction or rotation of the motor.
For Hoisting/Forward = Input terminal **5** bridged to **3**
For Lowering/Reverse = Input terminals **4 and 5** bridged to **3**

When set as “Yes”:
For Hoisting/Forward = Input terminal **5** bridged to **3**
For Lowering/Reverse = Input terminal **4** bridged to **3**

Note

Any other combination will cause a J. error fault, which indicates that either speed steps have been selected without a defined directional signal or in the event of this parameter being set as YES two directional inputs have been selected simultaneously

3.2.18. Load defaults

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
18	Load defaults	Load factory default parameters	Yes or No	-	No

This parameter returns all the parameters to factory default settings.

CAUTION

IF IT IS NECESSARY TO CHANGE PARAMETERS IT IS RECOMMENDED THAT THIS BE DONE IN A CONSERVATIVE MANNER AND ONLY WITH A FULL UNDERSTANDING OF EACH FUNCTION.

Note

The default values have been selected so that they will apply to most applications. Generally only parameters 1, 2 and 10 will require changing to suit actual motor information

3.3. TRAVEL APPLICATION PARAMETERS LIST

Table 3-2 lists the typical parameter settings for Travel version 8.00 applications.

Table 3-2 : Travel Parameter List

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
1	C.T. Ratio	CT ratio	50:1 to 3000:1	-	50:1
2	CT enable	CTs enable	Yes or No	-	Yes
3	Motor Current	Motor full load current	≤ 60% of CT ratio	-	10
4	O/L Class	Overload class type	2 or 5	-	5
5	Notch 1	Notch 1 speed	5% to 20%	1	10%
6	Notch 2	Notch 2 speed	5% to 40%	1	20%
7	Notch 3	Notch 3 speed	5% to 50%	1	30%
8	Notch Plugging	Notch plugging	Yes or No	-	Yes
9	Notch Plugging V	Notch plugg voltage	0% to 90%	5%	40%
10	Neutral Plugging	Neutral plugging	Yes or No	-	Yes
11	Neutral Plugging V	Neutral plugging voltage	0% to 90%	5%	70%
12	Brake Plugging V	Voltage to apply when plugging in the opposite direction	50% to 90%	5%	70%
13	Max Stall V	Maximum stall volts	20% to 80%	5%	70%
14	Minimum Start V	Minimum start volts	20% to 80%	5%	50%
15	N123 Accel	Acceleration time between slow speed notches	2 to 20 Sec	1	5
16	N4_Accel profile	Acceleration rate for full speed acceleration	2 to 20 Sec	1	5
17	Ph Shift Off Tim	Phase shifter off time delay	60 to 240 ms	20 ms	100 ms
18	N4 delay	Notch 4 delayed time	0 to 5 sec	1 sec	0 sec
19	Sep. dir signals	Separate directional signals	Yes or No	-	No
20	Load Defaults	Load factory default parameters	Yes or No	-	No

NOTE: All Travel Control software versions 8.xx must be used with Control Panel software versions 9.xx

3.4. PARAMETER DESCRIPTIONS – TRAVEL

The following paragraphs detail the various travel parameters.

3.4.1. Current Transformer Ratio

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
1	CT Ratio	CT ratio	50:1 to 3000:1	-	50:1

This parameter selects a current transformer ratio (CT ratio). Only CT ratios from the list can be used. The available CT ratios are:

THE AVAILABLE CT RATIO'S ARE					
50:1	100:1	200:1	300:1	400:1	500:1
600:1	800:1	1000:1	1200:1	1500:1	2000:1
2500:1	3000:1				

Note

CT's are optional for all travel applications.

3.4.2. Current Transformer Enable

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
2	CT Enable	CT's enable	Yes or No	-	Yes

By selecting "Yes" current monitoring and the overload thermal model is enabled. Selecting "No" all the Current related measurements are disabled. This means that, there is no monitoring of Current overload; unbalance and Overcurrent..

Note

This may be useful when more than one motor is used with a single THYROMAT. In this case it is recommended that individual motor protection is used.

3.4.3. Motor Current

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
3	Motor Current	Motor full load current	≤ 60% of CT ratio	-	10

This parameter sets the motor full load stator current (Motor flc).

The value to be used is the stator current related to the mechanical power for the specific duty.

CAUTION

DO NOT EXCEED THE MOTOR NAMEPLATE VALUE FOR THE APPLICABLE DUTY.

Note

This value should be determined during the design phase. This value is to be used by the thermal model to calculate overload conditions

3.4.4. Overload Class

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
4	O/L Class	Overload class type	2 or 5	-	5

This parameter selects the Class of overload that the thermal model uses as a reference.

Class 2:

Trip if stator current exceeds three times motor full load current (Motor flc) for a period exceeding 6,77 sec.

Class 5:

Trip if stator current exceeds three times motor full load current (Motor flc) for a period exceeding 16,7sec.

3.4.5. Notch Speed 1

3.4.6. Notch Speed 2

3.4.7. Notch Speed 3

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
5	Notch 1	Notch 1 speed	5% to 20%	1	10%
6	Notch 2	Notch 2 speed	5% to 40%	1	20%
7	Notch 3	Notch 3 speed	5% to 50%	1	30%

These three parameters set the intermediate slow speeds.

CAUTION

WHERE SPEEDS IN EXCESS OF 30% ARE SELECTED SPECIAL ROTOR RESISTANCE DESIGN MAY BE NECESSARY.

CONSULT YOUR LOCALL MH AUTOMATION REPRESENTATIVE FOR ASSISTANCE.

3.4.8 Notch Plugging

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
8	Notch Plugging	Notch plugging	Yes or No	-	Yes

This parameter enables or disables notch plugging.

3.4.9 Notch Plugging V

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
9	Notch Plugging V	Notch plugging voltage	0% to 90%	5%	40%

This parameter sets the notch plugging voltage for both directions.

Notch plugging when activated, makes use of dynamic reverse plugging, to retard the Travel motion to the required speed, the magnitude of the plugging torque is proportional to the square of the plugging voltage applied, therefore the voltage setting will have an effect on the smoothness of the motion operation.
It is suggested that in most applications a value not higher than 50% of supply voltage is used.

3.4.10 Neutral Plugging

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
10	Neutral Plugging	Neutral plugging	Yes or No	-	Yes

This parameter enables or disables neutral plugging.

3.4.11 Neutral Plugging V

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
11	Neutral Plugging V	Neutral plugging voltage	0% to 90%	5%	70%

Neutral plugging when activated, makes use of dynamic reverse plugging, to retard the travel motion to standstill. The magnitude of the plugging torque is proportional to the square of the plugging voltage applied, therefore the voltage setting will have an effect on the smoothness of the motion operation.

It is suggested that in standard applications a value not higher than 70% of supply voltage is used.

3.4.12 Brake Plugging V

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
12	Brake Plugging V	Voltage to apply when plugging in the opposite direction	50% to 90%	5%	70%

Brake plugging can not be disabled. To activate Brake plugging the operator moves the joystick into any notch in the opposite direction to the actual crane direction at the time.
The voltage applied determines the torque to be applied to retard the Travel motion.
It is suggested that Brake plugging is always set to a % Voltage higher than any one of the other two Plugging voltages mentioned above, but not higher than 80%.

If the system requires a Braking voltage higher than 80% it may indicate weakness on other aspects of the motion electrical design which may be solved by a complete analysis of the system by MH Automation engineers.

3.4.13. Maximum Stall Voltage

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
13	Max Stall V	Maximum stall volts	20% to 80%	5%	70%

This is the ceiling voltage applied to the motor in the event that the motor remains at standstill during operation. (i.e. Motor is stalled).

Usually a setting of 70% is sufficient to enable the motion to operate satisfactory.

It is sometimes necessary to increase this voltage, usually in the case of bad Travelling rails, with wide 'rail joint gaps' or worn out spots on the rails.

The increase of this voltage setting to accommodate for such problems should be done only as a temporary measure until the problem is repaired. Long periods of exposure of the motor to "STALL" conditions may result in the failure of the motor windings.

3.4.14. Minimum Start Voltage

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
14	Min Start V	Minimum start volts	20% to 80%	5%	50%

A setting of 40% minimum voltage at start, gives the travel motion a smooth, slow reaction start up.

By increasing this voltage the travel start up becomes more aggressive, the user will have the option to tune the start-up reaction time of the travel by modifying this parameter.

3.4.15. Notch 1; 2 and 3 Acceleration Time

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
15	N123 Accel	Acceleration time between slow speed notches	2 to 20 Sec	1	5

This parameter sets the acceleration time between speed notches.

Only applicable for slow speed notches 1; 2 and 3. When Notch 4 is required this ramp is bypassed.

Scale example:

A value of 5 indicates that the ramp is spanned from 0 to 5 seconds from 0% speed to 100% speed. 10% speed is then reached in 0,5 second. 30% speed is then reached in 1,5 second, providing that other external elements (such as load swing) don't interfere with the torque requirements to achieve this target rate of acceleration.

3.4.16. Notch 4_Accel Profile

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
16	Notch 4_Accel profile	Acceleration rate for full speed acceleration	2 to 20 Sec	1	5

Notch 4 acceleration profile is based on ramping the motor stator voltage as opposed to Notches 1; 2 and 3 acceleration profile which is based on a Speed ramp profile.

The system, when going to Notch 4, measures the voltage applied to the motor at the time and ramps it to full voltage at the rate determined by this parameter.

Example:
- During transition from any notch to notch 4 the voltage supplied to the motor was at 50%.
- The parameter is set at 5 sec.
- It will take a further 2.5 sec to ramp the voltage from 50% to 100%.

3.4.17. Phase Shifter Off Time

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
17	Ph Shift Off Tim	Phase shifter off time delay	60 to 240 ms	20 ms	100 ms

This parameter sets the time that the Phase Shifter is disabled (No current flowing to the motor) to allow the directional contactors to change over without arcing. Refer to similar parameter for Hoist application for further details.

3.4.18. Notch 4 Delay

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
18	N4 Delay	Notch 4 delay	0 to 5 sec	1	0

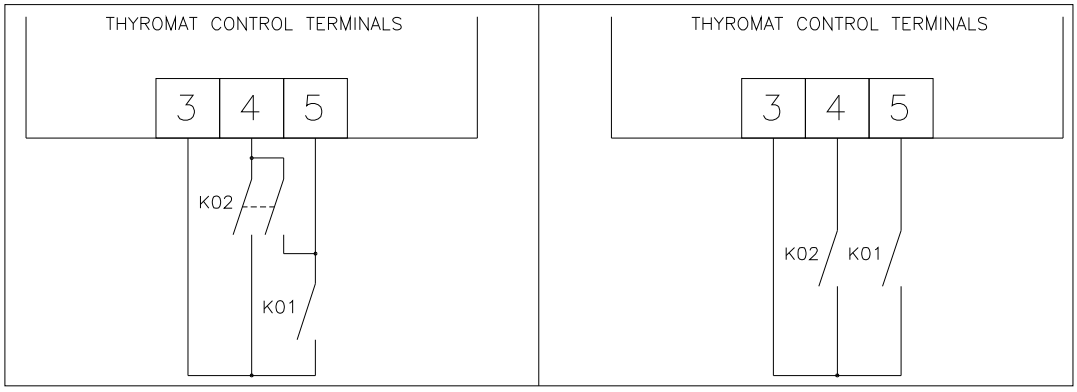
This parameter when set at a value > 0 inserts a time delay for engaging notch 4 “full speed”.

This is useful when the operation of the Crane requires the driver to perform short movements of the load. By adding a delay time to notch 4 it will prevent the accidental jump from slow speed operation (Speed ramp) to full speed operation (voltage “Torque” ramp).

3.2.19. Separate Directional Signals

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
19	Sep. dir signals	Separate directional signals	Yes or No	-	No

This parameter defines the way the input directions are selected.



When set as NO:
This is the way that Thyromat analogue and early digital units use to select the direction or rotation of the motor.
For Hoisting/Forward = Input terminal **5** bridged to **3**
For Lowering/Reverse = Input terminals **4 and 5** bridged to **3**

When set as YES:
For Hoisting/Forward = Input terminal **5** bridged to **3**
For Lowering/Reverse = Input terminal **4** bridged to **3**

Note

Any other combination will cause a J. error fault, which indicates that either speed steps have been selected without a defined directional signal or in the event of this parameter being set as YES two directional inputs have been selected simultaneously

3.4.20. Load Defaults

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
20	Load Defaults	Load factory default parameters	Yes or No	-	No

This parameter returns all the parameters to factory default settings.

CAUTION

IF IT IS NECESSARY TO CHANGE OTHER PARAMETERS IT IS RECOMMENDED THAT THIS BE DONE IN A CONSERVATIVE MANNER AND ONLY WITH A FULL UNDERSTANDING OF EACH FUNCTION.

Note

The default values have been selected so that they will apply to most applications. Generally only parameters 4 and 5 will require changing to suit actual motor information.

3.5. Torque Application Parameters List

Table 3-3 lists the typical parameter settings for torque version 1.00 applications.

Table 3-3 : Torque Parameter List

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
1	Load Defaults	Load factory default parameters	Yes or No	-	No
2	CTS Enable	CTs enable	true or false	-	True
3	O/L Class Type	Overload class type	2 or 5	-	5
4	CT Ratio	CT ratio	50:1 to 3000:1	-	50:1
5	Motor flc	Motor full load current	63% of CT ratio	-	10
6	Short cct	Short circuit	200% to 400%	100	400%
7	Start Volts	Start voltage applied until N1 delay complete	30% to 100%	1	70%
8	Notch 1 V	Voltage applied after N1 delay complete	30% to 100%	1	70%
9	Notch 2 V	Voltage applied after N2 delay complete and notch 2 has been engaged	30% to 100%	1	70%
10	Notch 3 V	Voltage applied after N3 delay complete and notch 3 has been engaged	30% to 100%	1	70%
11	N1 Delay	Delay time before notch 1 Voltage can be applied to the motor	50 ms to 9950ms	50ms	1000ms
12	N2 Delay	Delay time before notch 2 Voltage can be applied to the motor	50 ms to 9950ms	50ms	2000ms
13	N3 Delay	Delay time before notch 3 Voltage can be applied to the motor	50 ms to 9950ms	50ms	3000ms
14	N4 Delay	Delay time before notch 4 Voltage can be applied to the motor	50 ms to 9950ms	50ms	4000ms
15	Plug Volt 1	Plugging Voltage applied when notch 1 is selected in the opposite direction of rotation	30% to 100%	1	70%
16	Plug Volt 2	Plugging Voltage applied when notch 2 is selected in the opposite direction of rotation	30% to 100%	1	70%
17	Plug Volt 3	Plugging Voltage applied when notch 3 is selected in the opposite direction of rotation	30% to 100%	1	70%
18	Plug Volt 4	Plugging Voltage applied when notch 4 is selected in the opposite direction of rotation	30% to 100%	1	70%
19	1st Rotor	1st rotor contactor	40% to 100%	1	50%

20	2nd Rotor	2nd rotor contactor	40% to 100%	1	75%

3.6. PARAMETER DESCRIPTIONS – TORQUE

The following paragraphs detail the various torque parameters.

3.6.1. Load Defaults

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
1	Load Defaults	Load factory default parameters	Yes or No	-	No

This parameter returns all the parameters to factory default settings.

CAUTION

IF IT IS NECESSARY TO CHANGE OTHER PARAMETERS IT IS RECOMMENDED THAT THIS BE DONE IN A CONSERVATIVE MANNER AND ONLY WITH A FULL UNDERSTANDING OF EACH FUNCTION.

Note

The default values have been selected so that they will apply to most applications. Generally only parameters 4 and 5 will require changing to suit actual motor information.

3.6.2. Current Transformer Enable

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
2	CTS Enable	CTs enable	true or false	-	True

By selecting “true” current monitoring and the overload thermal model is enabled. Selecting “false” the thermal, short circuit and unbalance current protection is disabled.

Note

This may be useful when more than one motor is used with a single THYROMAT. In this case it is recommended that individual motor protection devices are used.

3.6.3. Overload Class

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
3	O/L Class Type	Overload class type	2 or 5	-	5

This parameter selects the Class of overload that the thermal model uses as a reference.

Class 2:

Trip if stator current exceeds three times motor full load current (Motor flc) for a period exceeding 6,77 sec.

Class 5:

Trip if stator current exceeds three times motor full load current (Motor flc) for a period exceeding 16,7sec.

Note

The percentage of thermal capacity used by the motor is displayed on the Control panel on Menu pages 1 to 3, line 2.

3.6.4. Current transformer ratio

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
4	CT Ratio	CT ratio	50:1 to 3000:1	-	50:1

This parameter selects a current transformer ratio (CT ratio). Only CT ratios from the list can be used. The available CT ratios are:

050:1	800:1
100:1	1000:1
200:1	1200:1
300:1	1500:1
400:1	2000:1
500:1	2500:1
600:1	3000:1

Note

CT's are optional for all travel applications.

3.6.5. Motor full load current

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
5	Motor flc	Motor full load current	63% of CT ratio	-	10

This parameter sets the motor full load stator current (Motor flc).

The value to be used is the stator current related to the mechanical power for the specific duty.

CAUTION

DO NOT EXCEED THE MOTOR NAMEPLATE VALUE FOR THE APPLICABLE DUTY.

Note

This value should be determined during the design phase. This value is to be used by the thermal model to calculate overload conditions

3.6.6. Short Circuit Detection

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
6	Short cct	Short circuit	200% to 400%	100	400%

This parameter sets the short circuit (Short cct) detection level.

CAUTION

THIS FUNCTION ALONE IS NOT SUFFICIENT TO PROTECT THE THYRISTORS DURING A SHORT CIRCUIT. TAKE NOTE OF THE APPLICABLE RECOMBINATIONS MADE ABOUT THE MAIN CIRCUIT BREAKER IN SECTION 2.

Note

The short circuit detection function assists in the protection of the motor and associated cables. The control is designed to achieve tripping times in the region of 20ms

3.6.7. Start Volts

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
7	Start Volts	Start voltage applied until N1 delay complete	30% to 100%	1	70%

This is the initial voltage applied to the motor when the joystick controller is moved to any notch not in opposition to the direction of rotation (if any). This is then applied until the notch one time delay has elapsed.

CAUTION

USING STARTING VOLTAGES GREATER THAN 75% MAY CAUSE EXCESSIVE CURRENT SPIKES AT STARTUP.

3.6.8. Notch Voltages

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
8	Notch 1 V	Voltage applied after N1 delay complete	30% to 100%	1	70%
9	Notch 2 V	Voltage applied after N2 delay complete and notch 2 has been engaged	30% to 100%	1	70%
10	Notch 3 V	Voltage applied after N3 delay complete and notch 3 has been engaged	30% to 100%	1	70%

These parameters set the voltages applied to the motor once the relevant notch delay has completed and the notch has been engaged.

Notes

1. **Use voltages set to 75, 85, 90% for notches 1 to 3 to start, with adjustment up or down according to the cranes requirements.**

2. **The torque provided in each notch is proportional to the square of the voltage applied. The values set should be specific to the torque required from each notch and checked both with light and heavy loads. The speed of acceleration will be affected by the values of these parameters, but the time delays of the notches will provide a more effective and practical adjustment of the acceleration.**

3.6.9. Notch delays

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
11	N1 Delay	Delay time before notch 1 Voltage can be applied to the motor	50 ms to 9950ms	50ms	1000ms
12	N2 Delay	Delay time before notch 2 Voltage can be applied to the motor	50 ms to 9950ms	50ms	2000ms
13	N3 Delay	Delay time before notch 3 Voltage can be applied to the motor	50 ms to 9950ms	50ms	3000ms
14	N4 Delay	Delay time before notch 4 Voltage can be applied to the motor	50 ms to 9950ms	50ms	4000ms

These parameters set the delay time from moving the joystick out of neutral before the voltage applied to the motor can progress to the next level if that notch has been selected.

Figure 3.1 shows an example of how these delays work if the joystick is moved from neutral to 4th notch quickly. The left graph uses the default delay settings as shown above, but the right graph shows how N3 V is skipped if the N4 Delay is set the same as N3 Delay at 3 seconds.

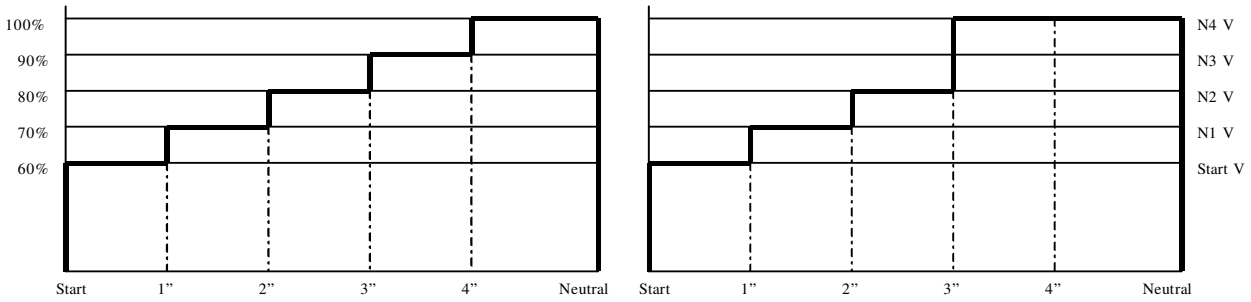


Figure 3-1 : Timer delay example

CAUTION

THESE TIMERS RUN SIMULTANEOUSLY AND ARE NOT ACCUMULATIVE, SETTING MORE THAN ONE NOTCH DELAY TO THE SAME VALUE WILL ALLOW THE VOLTAGE OF THE HIGHEST NOTCH SET TO BE APPLIED DIRECTLY TO THE MOTOR WITH THE INTERMEDIATE NOTCH VOLTAGES BEING BYPASSED.

Notes

1. **Reducing the delay of the lower notches can help compensate for heavy loads to maintain a reasonably quick acceleration by progressing quicker to the next torque level.**

2. **Reducing the delay of the lower notches too far will cause excessive currents in the motor during acceleration.**

3.6.10. Plugging Voltages

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
15	Plug Volt 1	Plugging Voltage applied when notch 1 is selected in the opposite direction of rotation	30% to 100%	1	70%
16	Plug Volt 2	Plugging Voltage applied when notch 2 is selected in the opposite direction of rotation	30% to 100%	1	70%
17	Plug Volt 3	Plugging Voltage applied when notch 3 is selected in the opposite direction of rotation	30% to 100%	1	70%
18	Plug Volt 4	Plugging Voltage applied when notch 4 is selected in the opposite direction of rotation	30% to 100%	1	70%

These parameters set the brake plugging voltage applied to the motor when the joystick is moved to the selected notch in the reverse direction to the rotation of the motor.

CAUTION

USING PLUGGING VOLTAGES GREATER THAN 70% ON A 30% RESISTOR WILL EXPOSE THE MOTOR AND MECHANICAL COMPONENTS TO HIGH TORQUE OUTPUTS WHICH MAY NOT BE DESIRABLE IN THE LONG TERM.

Note

The plugging voltage can be set very low in the lower notches to provide gentle braking, getting progressively higher as the notch position increases to provide quicker but harsher braking. 4th notch may require a voltage as high as 75 to 80% to provide a quick enough response when a fast stop is required.

3.6.11. 1st Rotor

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
19	1st Rotor	1st rotor contactor	40% to 100%	1	50%

This parameter determines the speed at which the output for the first rotor contactor is energised. The installation of this contactor is recommended in travel systems where it is critical to run the motor at a speed closer to its rated synchronous speed. Depending on the load driven, the amount

of slip resistance left may be 0.15 p.u (0.15k). This should take the motor top speed to approximately 85 to 90% of its synchronous speed.

3.6.12. 2nd Rotor

NO	PARAMETER	DESCRIPTION	SCALE	INCREMENT	DEFAULT
20	2nd Rotor	2nd rotor contactor	40% to 100%	1	75%

This parameter determines the speed at which the output for the second rotor contactor is energised. The installation of this contactor is recommended in travel systems where it is critical to run the motor at a speed closer to its rated synchronous speed. Depending on the load driven, the amount of slip resistance left may be 0.07 p.u (0.07k). This should take the motor top speed to approximately 90 to 95% of its synchronous speed.

4. SECTION 4 : INSTALLATION

4.1. GENERAL INSTALLATION

The THYROMAT is a complete bolt-on unit keeping the installation simple. The control unit is encapsulated in it's own dust proof enclosure and is mounted to the thyristor stack. Similarly the thyristor stack is a bolt on unit and is also secured to the equipment (differences in the mounting arrangement of the thyristor stack depend on the model to be used). The electrical interface with the equipment is by means of terminal lugs and/or connector blocks.

Certain THYROMAT variations have protective covers over the thyristor stacks. The cover serves as a protective screen to prevent damage to property and personal injury from accidental contact with the exposed live components of thyristor stacks.

4.2. MECHANICAL INSTALLATION

4.2.1. General

The THYROMAT is a simple item to mount. THYROMAT is provided with the correct fasteners to secure the unit on to the mounting surface. In the event that a repairable item is removed for repairs place the fasteners in safekeeping for future use. When replacing repaired units use the original fasteners, wherever necessary replace damaged or lost fasteners with physical equivalents.

4.2.2. Mounting Instructions

Before mounting the THYROMAT, make sure that the mounting surface is of sufficient physical strength to carry the weight of the complete unit. The following paragraphs list the mounting instructions for the THYROMAT, refer to figure 4-1 for mounting details:-

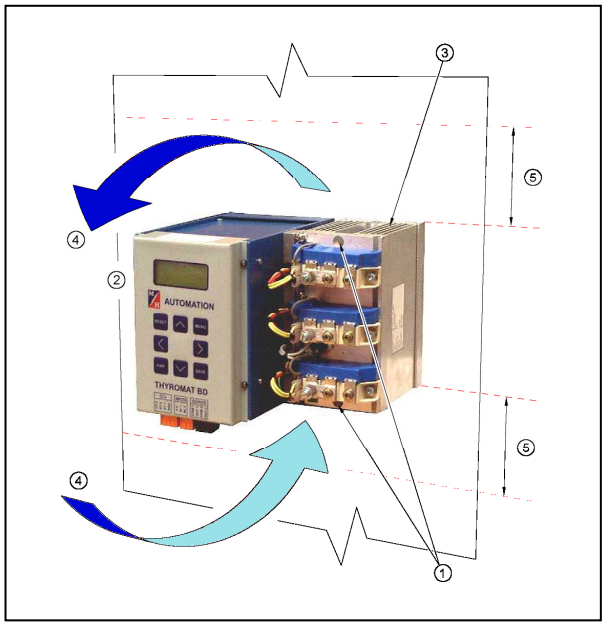


Figure 4-1 : Mounting The THYROMAT - BD Crane Controller

1. Mount the THYROMAT using the mounting holes provided by the thyristor stack (1). It is important to note that the mounting screws also provide the unit with an additional earth return, make sure that the unit's mountings are clean and that a good earth is established.

2. Excessive vibrations can be caused by various factors such as machine operation and / or reversing contactors etc. In order to minimise the vibration, which contributes to the mechanical wear in the THYROMAT it is suggested that the unit should be mounted close to the edge of the designated mounting panel (2).

3. The THYROMAT must be mounted to a vertical surface with the cooling fins on the thyristor stack aligned in the vertical direction (3)

4.&5. The heat displaced by the THYROMAT must be dissipated by effective airflow. Therefore provision must be made to allow for sufficient air circulation (4) to aid in the cooling of the THYROMAT. A minimum space of 150 mm at the top and 150 mm at the bottom of the THYROMAT (5) must be free of obstructions to allow for sufficient airflow to cool the unit.

4.2.3. Tools and Special Equipment

Table 4-1 lists the Tools and Special Equipment (Mechanical) needed to mount the THYROMAT.

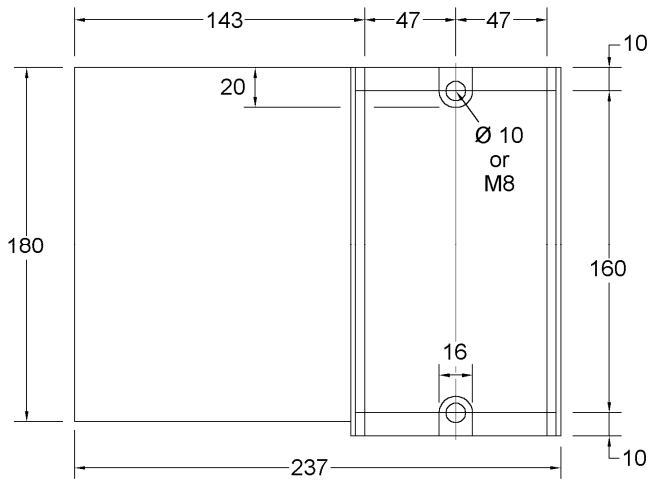
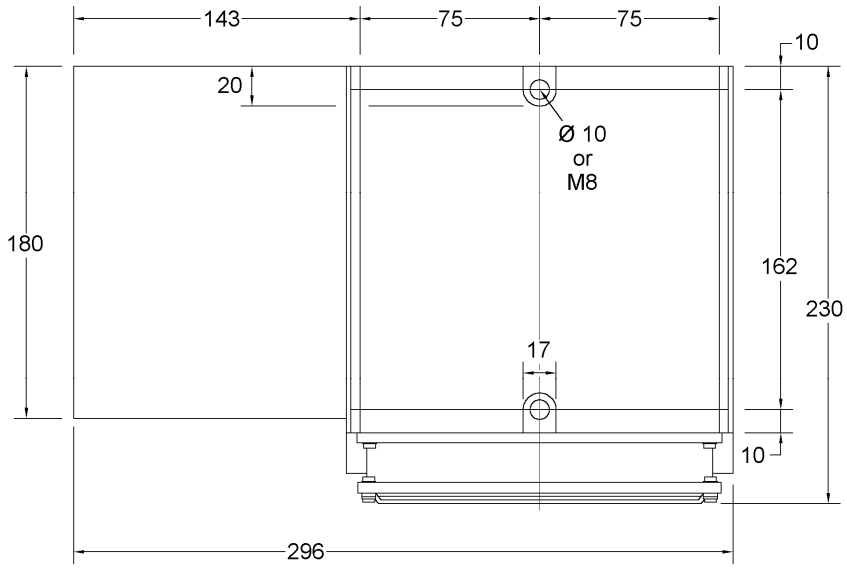
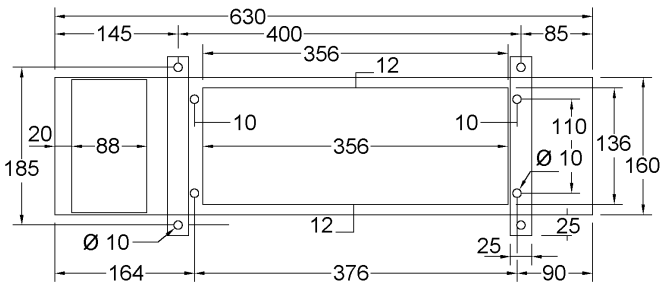
Table 4-1 : Tools and Special Equipment (Mechanical)

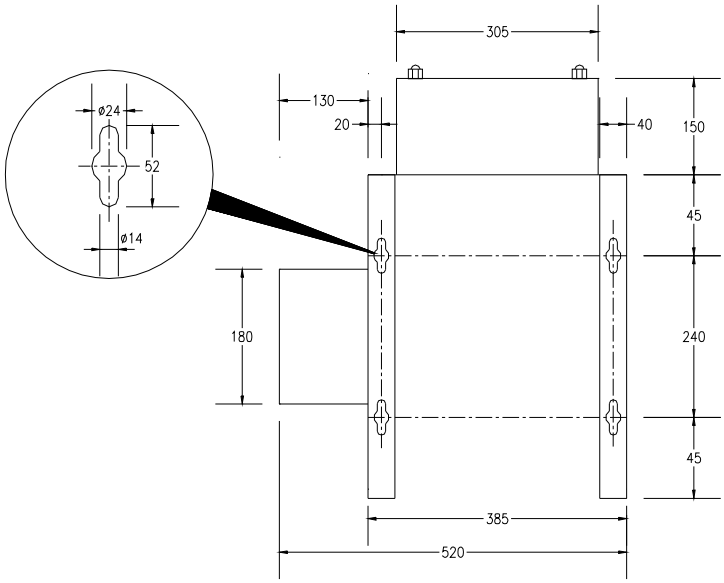
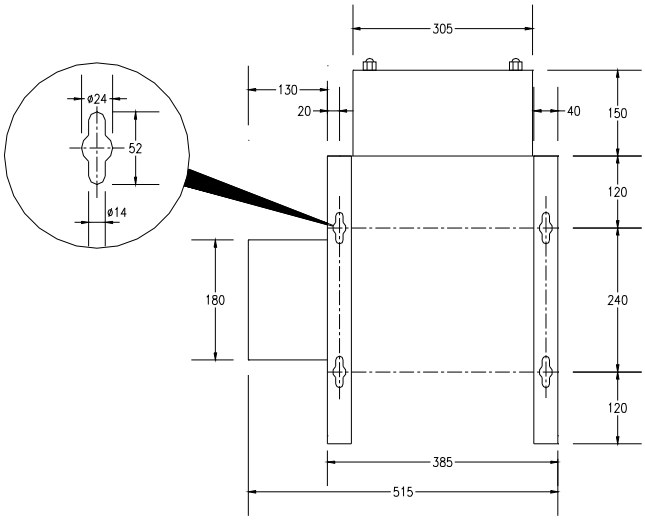
TOOLS / EQUIPMENT	THYROMAT - BD Digital Crane Controller Mechanical Size					
	M100	M150	M350	M500	M1000	M2000
Marking Pen	X	X	X	X	X	X
Ruler / tape measure	X	X	X	X	X	X
Spirit Level	X	X	X	X	X	X
Hammer	X	X	X	X	X	X
Centre Punch	X	X	X	X	X	X
Drilling Machine	X	X	X	X	X	X
Extension Lead	X	X	X	X	X	X
Screw Driver	X	X	X	X	X	X
6,5 mm Drill Bit	X	X	-	-	-	-
8 mm Drill Bit	-	-	X	X	X	X
13 mm Spanner	-	-	X	X	X	X
Metric tap set 8 mm	X	X	-	-	-	-
Metric tap set 10 mm	-	-	X	X	X	X

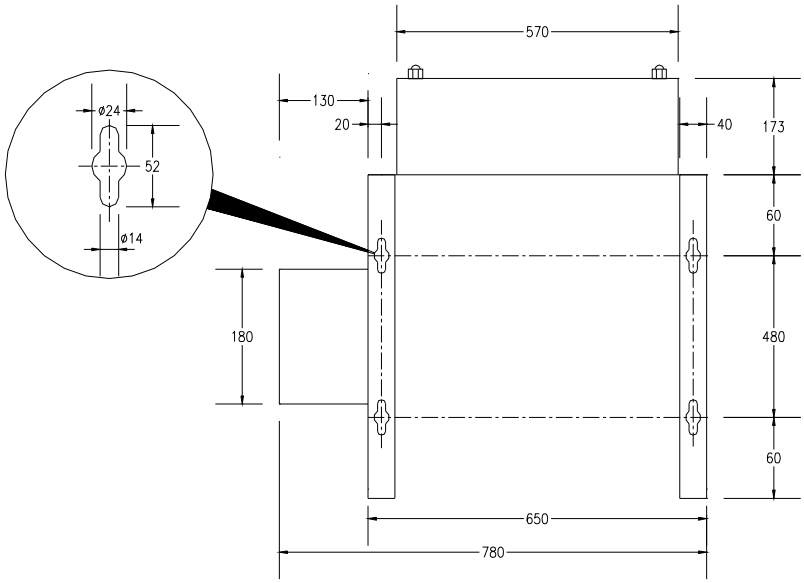
4.2.4. Mounting Arrangements

Table 4-2 lists the mechanical mounting arrangement for the various THYROMAT controllers.

Table 4-2 : Mechanical Mounting Arrangements of THYROMAT - BD Digital Crane Controllers

MECHANICAL SIZE	MOUNTING HOLE ARRANGEMENT (measurement in mm)
M100	
M150	
M350	

MECHANICAL SIZE	MOUNTING HOLE ARRANGEMENT (measurement in mm)
M500	
M1000	

MECHANICAL SIZE	MOUNTING HOLE ARRANGEMENT (measurement in mm)
M2000	

4.2.5. Mounting Procedure

- Identify a suitable mounting surface.
- Clean the mounting surfaces and make sure that they are free of any oil or grease.
- Mark the mounting holes in accordance with the applicable instructions and dimensions identified in paragraphs 4.2.2. (Mounting Instructions) and 4.2.4. (Mounting Arrangements). Use the spirit level to ensure that the unit will be mounted level.
- Using the hammer and centre punch, punch the applicable centres for the mounting holes.
- Using the electric drill and applicable drill bit, drill the mounting holes, take care not to damage any objects and / or equipment that may be mounted on the opposite side of the mounting surface.
- Make sure that the mounting surfaces around the holes are stripped of paint and free of any grease or oil so that a good earth can be obtained.
- With the aid of an assistant, lift the THYROMAT into position.
- Insert the fasteners provided and secure the THYROMAT to the mounting surface using the applicable tools. Where bolts are used to mount the THYROMAT, make sure that they are torqued down to the correct values (refer to table 4-3 Mounting Fastener Torque Values).
- Clean up the immediate area of all iron filings and / or metal shavings.
- Remove all tools and / or materials used in the mounting process.

Table 4-3 Mounting Fastener Torque Values

MECHANICAL SIZE	SCREW 8 mm	BOLT 10 mm
M100	7 Nm	-
M150	7 Nm	-
M350	-	15 Nm
M500	-	15 Nm
M1000	-	15 Nm
M2000	-	15 Nm

4.3. ELECTRICAL INSTALLATION

4.3.1. General

WARNINGS

1. **DO NOT ATTEMPT TO MAKE ANY CONNECTIONS TO THE THYROMAT WHILE IT IS CONNECTED TO THE MAINS POWER (LIVE).**
2. **AFTER DISCONNECTING THE THYROMAT FROM THE MAINS POWER, USE A MULTI-METER TO MAKE SURE THAT ALL POWER HAS BEEN REMOVED.**
3. **DISCONNECT THE MOTOR CABLES BEFORE ATTEMPTING TO TAKE ANY MEASUREMENTS ON THE MOTOR CABLES.**
4. **MAKE SURE THAT ALL THE COVERS TO THE CONTROLLER ARE SECURED IN THEIR CORRECT POSITIONS BEFORE SWITCHING ON THE MAINS POWER.**

CAUTIONS

1. **DO NOT MAKE ANY VOLTAGE WITHSTAND TESTS ON ANY PART OF THE THYROMAT - BD BD DIGITAL CRANE CONTROLLER.**
2. **DO NOT TOUCH ANY OF THE COMPONENTS ON THE CIRCUIT BOARDS, THEY ARE VOLTAGE SENSITIVE AND MAY BE DAMAGED / DESTROYED.**
3. **MAKE SURE THAT THERE ARE NO POWER FACTOR CORRECTION CAPACITORS CONNECTED TO THE MOTOR POWER CABLE.**

NOTE

1. **Only a competent licensed Electrician or a suitably qualified person should be allowed to install the THYROMAT.**
2. **It is important to shield the control electronics from any magnetic inductance that could be generated by large current carrying conductors.**

The THYROMAT has simple fasteners for connecting electrical power. The connection points are clearly marked to aid installation.

4.3.2. Electrical Connection Instructions.

Before connecting the electrical cables to the THYROMAT, make sure that the unit has been firmly secured to the mounting panel, refer to figure 4-2 for the electrical mounting details.

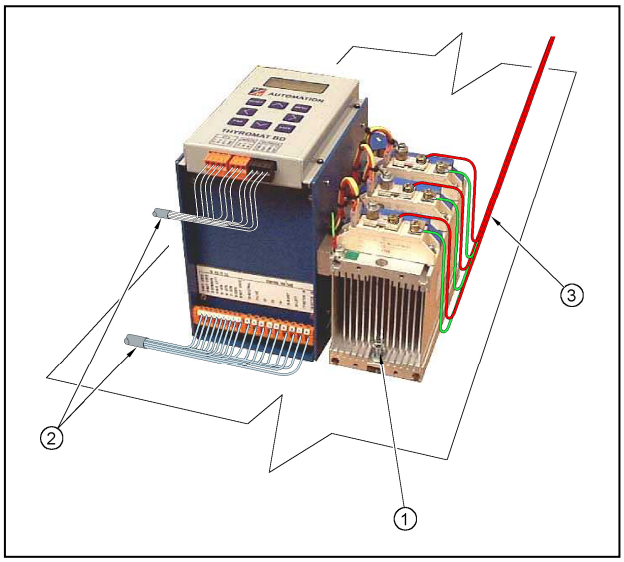


Figure 4-2 : Electrical Mounting of The THYROMAT Controller

1. Check that the integrity of the earth between the THYROMAT and mounting surface is good (the measured resistance should be 0 ohms). In the event that the earth does not conform, make sure that the THYROMAT mountings and the mounting surface are stripped clean of paint and other contamination (1), if necessary install an additional earth strap.

2. Make sure that all the leads to the THYROMAT unit have a fair amount of slack so that they do not assert unnecessary mechanical stresses to the electrical terminals (2).

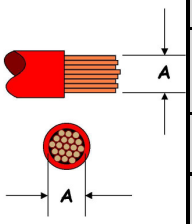
2.&3. When connecting the electrical cables to the THYROMAT and thyristor stack ((2) & (3)), make sure that the correct connector lug sizes are used (refer to Table 4-4 Connector Lug Data).

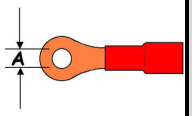
Where fasteners are used to connect the electrical lugs to the THYROMAT, make sure that they are torqued down to the correct values (refer to Table 4-4 Connector Lug Data).

The THYROMAT must always have an earth connected to the earth terminal provided on the controller's terminal strip.

3. Make sure that all the leads to the thyristor stack have a fair amount of slack so that they do not assert unnecessary mechanical stresses to the electrical terminals (3).

Table 4-4 : Connector / Lug Gauge and Sizes

Connector / Lug Detail		Current Rating	THYROMAT Mechanical Size					
			M100	M150	M350	M500	M1000	M2000
WIRE SIZE IN mm^2		25 A 30 A 60 A	4 6 16	-	-	-	-	-
		100 A 150 A	-	25 35	-	-	-	-
		200 A 350 A	-	-	50 75	-	-	-
		400 A	-	-	-	120	-	-
		500 A 700 A 1 000 A	-	-	-	-	150 240 330	-
		1 200 A 1 500 A 2 000 A	-	-	-	-	-	480 600 960

Connector / Lug Detail		Current Rating	THYROMAT Mechanical Size					
			M100	M150	M350	M500	M1000	M2000
LUG		25 A 30 A 60 A	4 x 6 6 x 6 16 x 6	-	-	-	-	-
		100 A 150 A	-	25 x 8 35 x 8	-	-	-	-
		200 A 350 A	-	-	70 x 8 95 x 10	-	-	-
		400 A	-	-	-	120 x 12	-	-
		500 A 700 A 1 000 A	-	-	-	-	150 x 12 240 x 12 or 120 x 12 2 cable/PH 150 x 12 2 cable/PH	-
		1 200 A 1 500 A 2 000 A	-	-	-	-	-	240 x 14 300 x 14 or 150 x 14 2 cable/PH 240 x 14 4 cable/PH
FASTENER TYPE		25 A 30 A 60 A	M 5 M 5 M 5 (screw)	-	-	-	-	-
		100 A 150 A	-	M 6 M 6 (screw)	-	-	-	-
		200 A 350 A	-	-	M 6 (screw) M 8 (bolt)	-	-	-
		400 A	-	-	-	M 10 (bolt)	-	-
		500 A 700 A 1 000 A	-	-	-	-	M 10 M 10 M 10 (bolt)	-
		1 200 A 1 500 A 2 000 A	-	-	-	-	-	M 12 M 12 M 12 (bolt)

Connector / Lug Detail		Current Rating	THYROMAT Mechanical Size					
			M100	M150	M350	M500	M1000	M2000
TORQUE VALUES IN Nm		25 A 30 A 60 A	N/A	-	-	-	-	-
		100 A 150 A	-	N/A	-	-	-	-
		200 A 350 A	-	-	N/A 5	-	-	-
		400 A	-	-	-	7	-	-
		500 A 700 A 1 000 A	-	-	-	-	7 7 7	-
		1 200 A 1 500 A 2 000 A	-	-	-	-	-	15 15 15
CURRENT DENSITY IN AMPERES PER mm^2		25 A 30 A 60 A	6,25 5 3,75	-	-	-	-	-
		100 A 150 A	-	4 4,28	-	-	-	-
		200 A 350 A	-	-	4 3,68	-	-	-
		400 A	-	-	-	3,33	-	-
		500 A 700 A 1 000 A	-	-	-	-	3,33 2,91 3,03	-
		1 200 A 1 500 A 2 000 A	-	-	-	-	-	2,5 2,5 2,1

4.3.3. Tools and Special Equipment.

Table 4-5 lists the Tools and Special Equipment (Electrical) needed to connect the electrical functions of the THYROMAT.

Table 4-5 : Tools and Special Equipment (Electrical)

TOOLS / EQUIPMENT	THYROMAT - BD Digital Crane Controller Mechanical Size					
	M100	M150	M350	M500	M1000	M2000
Multimeter	X	X	X	X	X	X
Insulation tester	X	X	X	X	X	X
Diagonal pliers	X	X	X	X	X	X
Wire stripper or knife	X	X	X	X	X	X
Lug crimping pliers	X	X	X	X	X	X
Screwdriver flat no. 1	X	X	X	X	X	X
Screwdriver flat no. 2	X	-	-	-	-	-
Phillips screwdriver no. 1	-	X	-	-	-	-
Phillips screwdriver no. 2	-	-	X	-	-	-
Torque wrench	-	-	-	-	X	X
13 mm Socket	-	-	X	-	-	-
17 mm Socket	-	-	-	X	X	X

4.4. INSTALLATION DIAGRAMS

The following paragraph details the installation diagrams for the THYROMAT for both hoist and travel applications.

4.4.1. Digital Inputs – Main Board

Figure 4-3 illustrates the installation diagram for the digital inputs to the main board.

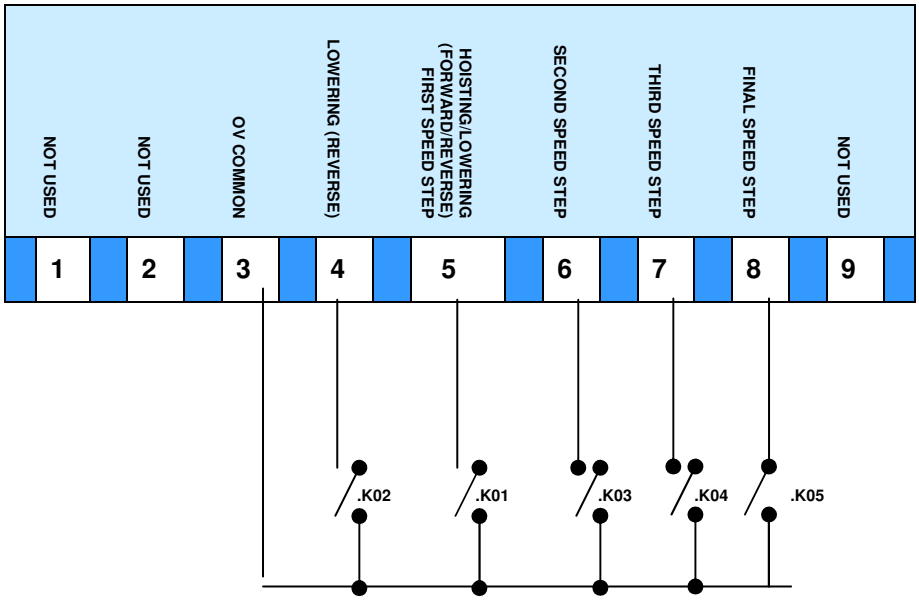


Figure 4-3 : Digital Inputs for the Main Board

- **Hoist Applications.**

  .K01 - Hoisting command and fist speed step selection.

  .K02 - Lowering command and first speed step selection.

  .K03 - Second speed step selection.

  .K04 - Third speed step selection.

  .K05 - Final speed step selection.

- **Travel Applications.**

  .K01 - Forward command and first speed step selection.

  .K02 - Reverse command and first speed step selection.

  .K03 - Second speed step selection.

  .K04 - Third speed step selection.

  .K05 - Final speed step selection.

4.4.2. Digital Inputs – Connectors on the Control Panel

Figure 4-4 illustrates the installation diagram for the digital inputs to the control board.

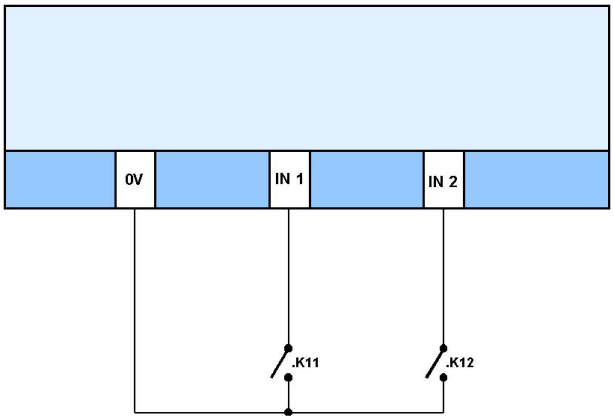


Figure 4-4 : Digital Inputs for the Connectors on the Control Panel

.K11 - Not used in standard hoist and travel applications.

.K12 - Not used in standard hoist and travel applications.

4.4.3. Relay Outputs – Connectors on the Main Board

Figure 4-5 illustrates the installation diagram for the relay outputs from the connectors on the main board.

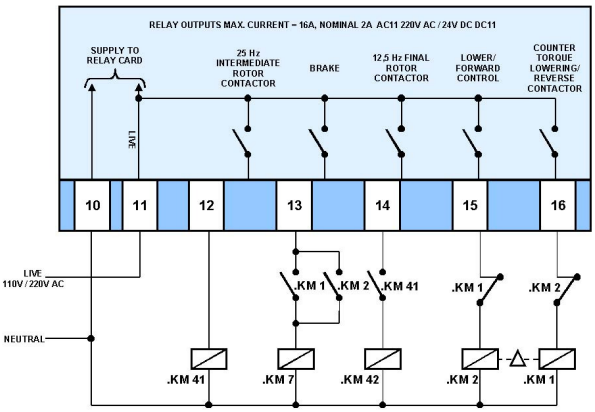


Figure 4-5 : Relay Outputs for the Connectors on the Main Board

- **Hoist Applications.**

.KM1 - Hoisting and counter torque lowering contactor.

.KM2 - Lowering contactor.

.KM7 - Brake contactor.

.KM41 - Intermediate or 1ST rotor contactor.

.KM42 - Final or 2ND rotor contactor.

- **Travel Applications.**

  .KM1 - Reverse contactor.

  .KM2 - Forward contactor.

  .KM7 - Brake contactor.

  .KM41 - Only required in special applications.

  .KM42 - Only required in special applications.

4.4.4. Triac Outputs – Control Panel Board

Figure 4-6 illustrates the installation diagram for the triac outputs from the control board.

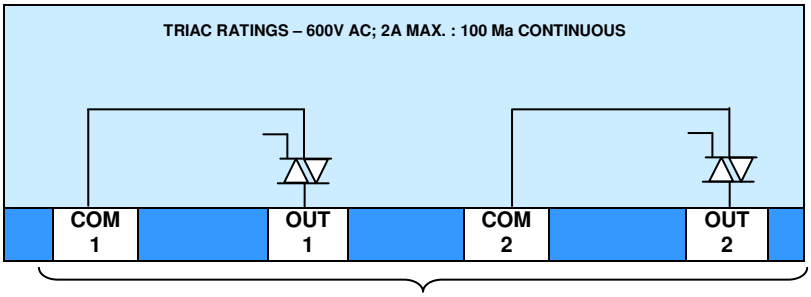


Figure 4-6 : Triac Outputs from the Control Panel Board

- **Hoist Applications.**

  Out 1 - .K06 - Not used

  Out 2 - Not used

- **Travel Applications.**

  Out 1 - .K06 - Not used

  Out 2 - Not used

4.4.5. Motor Current Inputs

Figure 4-7 illustrates the installation diagram for the motor current inputs.

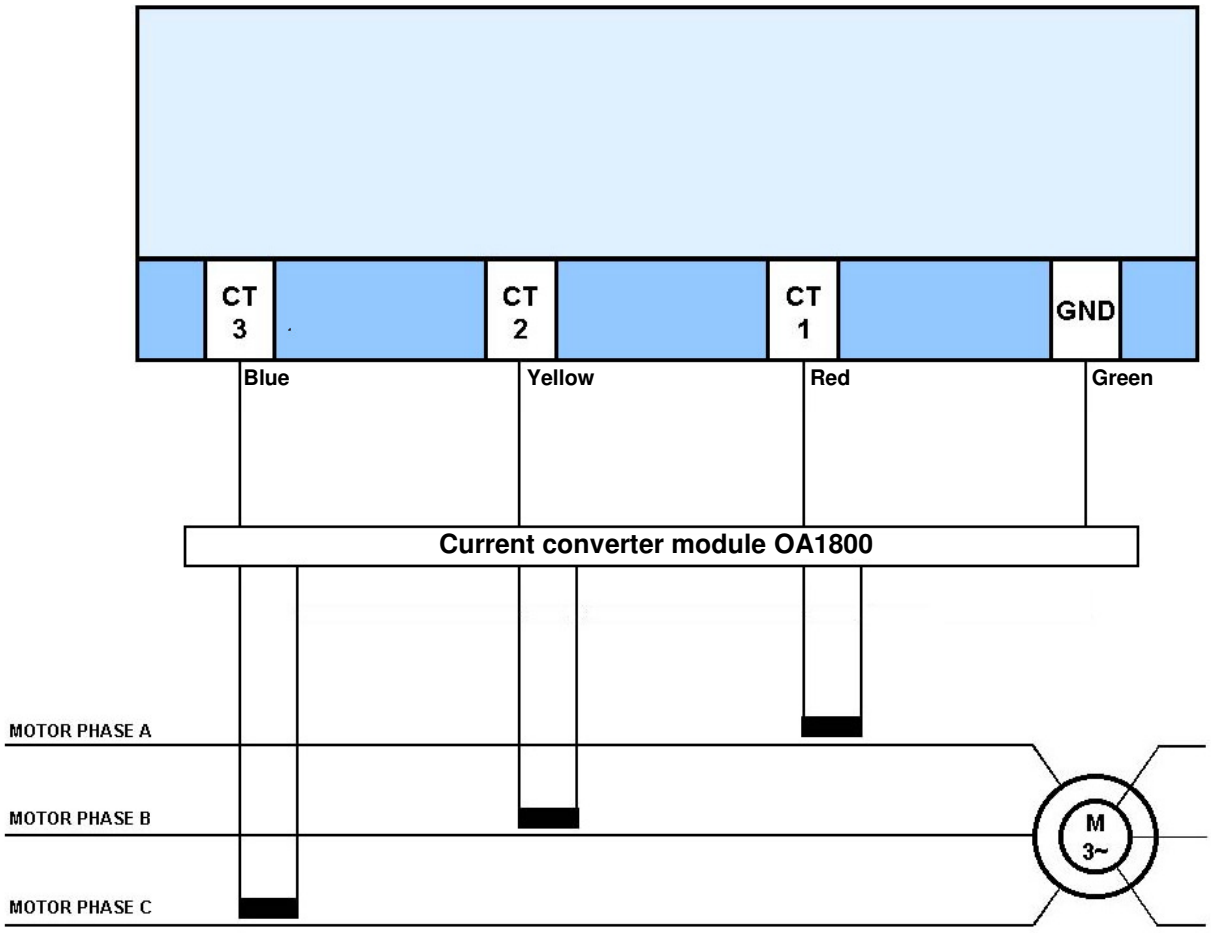


Figure 4-7 : Motor Current Inputs

- **Hoist Applications.**

  CTs always required.

- **Travel Applications.**

  CTs optional.

5. SECTION 5 : COMMISSIONING

5.1 GENERAL

Commissioning of the THYROMAT is simplified by default parameters displayed on the control panel (e.g. the operating functions during the functional testing phase of the commissioning process). Equipment configuration and operational adjustments in the event of unique applications are finalised when commissioning the equipment.

It is important to observe the warnings and cautions before commencing with the commissioning procedure.

5.2 PREPARATION

WARNINGS

1. **HIGH VOLTAGE COMPONENTS, ACCIDENTAL CONTACT WITH THYRISTOR STACKS CAN RESULT IN FATAL INJURIES.**

2. **ONCE CONNECTED TO THE MAINS SUPPLY, ALL INTERNAL COMPONENTS OF THE CONTROL UNIT (EXCEPT ISOLATED I/O TERMINALS) ARE AT MAINS POTENTIAL.**

3. **WHEN THE THREE-PHASE SUPPLY IS CONNECTED TO THE THYRISTOR STACK AND MOTOR (CONNECTIONS U. V AND W) THE THYRISTOR STACK IS CONTINUALLY LIVE EVEN THOUGH THE MOTOR IS NOT RUNNING.**

4. **DO NOT ATTEMPT TO MAKE ANY CONNECTIONS TO THE THYROMAT WHILE IT IS CONNECTED TO THE MAINS POWER.**

5. **AFTER DISCONNECTING THE MAINS POWER USE A MULTI-METER TO MAKE SURE THAT THERE IS NO SUPPLY VOLTAGE PRESENT.**

6. **MAKE SURE THAT ALL THE COVERS TO THE CONTROLLER ARE SECURED IN THEIR CORRECT POSITIONS BEFORE SWITCHING ON THE MAINS.**

CAUTIONS

INCORRECT INSTALLATION OF THE THYROMAT BD DIGITAL CRANE CONTROLLER CAN RESULT IN DAMAGE TO EQUIPMENT AND / OR PROPERTY.

5.3. COMMISSIONING PROCEDURES

The following paragraphs detail the sequence that the commissioning process must follow to ensure that the equipment is commissioned correctly:

Step 1

Ensure that all internal and external power and control connection are done according to schematic drawings.

Step 2

Ensure that all external circuits are clear from earth faults as well as possible short circuits, which may have occurred during installation. When testing cables and motors with an earth insulation meter ensure that the Thyromat drive is not connected to the equipment under test. Megger high voltage testers may cause permanent damage to the drive.

Step 3

Ensure that the rotor resistances are wired correctly, MH Automation always provides the correct values of the resistance steps on the respective rotor schematic diagram. Follow these correctly to ensure that motor performance is correct from the start.

NOTE

Check that the rotor feedback wiring is wired exactly as in the schematic drawings.

Step 4

Verify that the Power supply and control supply are present at the panel and the Thyromat unit installed is rated accordingly. This should be done before the Main c.b. and the control c.b.'s are turned ON.

Step 5

Turn the control c.b. ON first, go through the notches one by one, verify that the correct input interposing relays switch in the correct sequence.

Step 6

Test the end of course limit switches, ensuring that they will trip the correct input interposing relays. Test the final limit switch and emergency stop circuit to ensure that these devices will offer the maximum protection as far as interruption of the main supply to motors and brakes is concerned. This specific test is extremely important and it may not be neglected.

Step 7

Powering up of the Thyromat drive. After ensuring that there are no earth faults or short circuits, the motion main c.b. may be turned ON. The Thyromat drive will display a power up page, which indicates the type of motion and the version group of its software program. In the event of this page

remaining on the display, with periodic reset followed by the same displaying of this page, an Input supply phases has occurred, which does not allow the Thyromat unit to carry further testing prior to the "Health Status" is given.

Possible causes of initial power-up Input phases failure:

- Wrong phase rotation: Turn the power OFF then correct phase rotation before turning the power ON once again
- The Incoming 3-phase supply is below acceptable values, (i.e. < 75% of its rated supply voltage)
- The Incoming 3-phase supply has a phase imbalance.

Step 8

Input the motor parameters as necessary. At this stage the only parameter which should be modified are the parameters which refer to the motor size and those are the following:

- C.T. ratio
- Motor current

All other parameters should remain as per default values. Save the parameter changes before continuing with the tests.

Step 9

Perform Locked Rotor test (Open rotor circuit)

a) Ensure that there is no load on the crane hook

b) Turn main c.b. OFF

c) Open star-point from rotor resistance or open two rotor resistance phases from rotor circuit

d) Make sure that the brake contactor will not energize. This may be achieved by opening the brake contactor coil circuit at any point in that control circuit.

(Remove wire from terminal 13 on Thyromat)

e) Turn Main c.b. ON

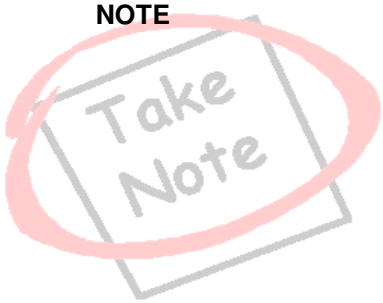
f) Wait for Thyromat drive Healthy Status to be displayed

g) Move the cabin joystick to Notch 1 Hoisting

h) Measure the stator and rotor voltages between phases at the motor terminals

i) Confirm that the Stator/Rotor voltage ratio falls within + 10% of name plate

NOTE



This test may only be performed for periods of approximately 10 seconds at the time since the Thyromat drive will trip on motor stall, if it remains for longer periods in Notch 1.

Analyzing the results:

When the above mentioned voltage ratio falls within the recommended± 10% deviation the test is considered successful, and the next test must now be performed. When such ratio is out the recommended deviation, one needs to verify why this is the case.

In the case of an upgraded installation it may be that the motor may have been rewound previously and its characteristics have changed slightly, if the deviation is too great, it may be possibly that the Rotor connections have been changed from Y to Δ or vice-versa. In this case the motor may not perform well under full load conditions and it may be necessary to replace it with a standby spare motor.

Under a great discrepancy on the rotor voltage, the rotor resistance which was calculated around the motor name plate values is going to be inadequate too and this needs to be taken in consideration as well.

Consult MH Automation for advice in the event that the results are out of acceptable boundaries.

Step 10

Perform locked Rotor test (Closed rotor circuit) (this test should only be performed if the test mentioned in Step 8 is successful).

a) Repeat step by step all the instructions referred to in Step 9 (a) to (g).

h) Measure the stator voltages between phases. The supply voltage must remain within 90% of its rated value, preferably > 95%. Look out for any major phase imbalances.

i) Measure the stator currents per phase. These currents should be fairly balanced.

j) Measure the rotor voltages at the motor terminals between phases.

k) Measure all three rotor currents (at the motor terminals)

l) Assuming that there are no major unbalances in either rotor voltages or currents, take the average values of both and apply them to the formula below

Motor kW = Rotor volts x Rotor amps / 605

The resultant kW for a maximum stall voltage of 80% and a Rotor resistance of 0,36k should be approximately the same as the kW which the system has been designed for.

NOTE

This may not correspond to the rated name plate kW of the motor if the resistance was calculated based on the motion mechanical power. Usually the

schematic diagrams will make reference to the exact motor kW which the system has been designed for.

Helpful Hint:

With the maximum stall voltage set at 80% of the supply:

As a general rule, under this test condition the rotor voltage will drop by a factor close to 1,5 of its name plate value. The mechanical or electrical current (depending on the design) will increase by the same factor.

Major deviations from these general rules it may indicate problems which may require further investigation. It is not possible to elaborate on the causes of the problem due to an immense variety of causes which may influence the results obtained during the tests.

It would be advisable to get in contact with the Technical department at MH Automation or any of their accredited representatives or agents for further assistance.

Step 11

After these tests are performed and assuming that both have had satisfactory results, the brake contactor coil should be reconnected as recommended and proceed with the next step.

Step 12

No load test: Run the motion in both directions notch by notch to ensure that the direction of rotation is correct and there are no other problems. In the case of Hoist motions the rotary limit switch top and bottom should now be tested.

In the case of Travel motions, slow down and end of course limits if applicable should now be tested.

During the No-Load test, ensure that there are no visible arcing on the contactors. When all the contactors switching times are known it is easy to set up the parameters to avoid contactor arcing, but in some cases it is not possible to determine the switch in and drop out times of the contactors and a practical way of achieving no arcing is by running the Hoist motion in the lowering direction, between 4th and 3rd notches. This way the reversing contactors as well as the rotor contactors will all be operating, check for possible arcing and if present increase the Phase Shifter OFF time.

Step 13 (Hoist only)

Monitor the operation of the brake contactor versus the directional contactors. At the end of any cycle the brake contactor should de-energize first. The power will remain on the motor for a further 500 to 1050 msec. depending on the setting of the respective parameter (Stop delay). Only after this time has expired the directional contactor will drop out.

Step 14 (Hoist only)

Test under load conditions: Run the motion in both directions notch by notch. Specifically look out for the operation of the brake drum. During Hoisting operation, the brake drum must not turn in reverse (lowering direction), if this happens it may indicate one of the following:

- Load is greater than the safe working load (SWL) of the Hoist motion
- The supply is weak, and under load conditions it drops drastically
- The Rotor resistances are not correctly designed

- The motor is not performing as per manufacturers design, this may occur after several rewinds

The above mentioned problems may also be causing the motor not to accelerate to full speed under load conditions.

During lowering operations, the following aspects must be checked:

The motor maintains the required slow speeds. When accelerated to full speed and then returned to “neutral” position the deceleration to full stop should be achieved within reasonable time (i.e. approximately 3 sec). At stop, the brakes should apply when the motor is at standstill or just started turning in the opposite direction.

Failure of achieving the above may be caused by one or several of the reasons already described above for hoisting operation.

GENERAL NOTE

It is always good practice to record in some form all current readings during the above tests. These readings serve as a base for future comparisons, specifically after a motor or a section of the rotor resistance has been replaced for whatever reason.

Step 15

During hoisting measure the peak stator currents during acceleration to full speed under full load conditions, ensure that these currents are well within 2,5 x motor nominal stator current. A sudden rise in current well above this value specifically during switching of any of the rotor contactors may indicate problems in the wiring of the rotor resistance.

This needs to be carefully checked and compared to the schematic diagrams supplied.

5.4. HOIST OPERATION

The following paragraphs detail the operational procedures during hoisting operations;

5.4.1. Hoisting

As soon as one of the four hoisting speeds on the master controller is selected, the THYROMAT will activate the hoist contactors which will supply voltage to the motor, a short time delay is provided before the brake is released. The motor will accelerate at a rate determined by the acceleration profile. Selecting one of the three slow speeds will regulate the motor at the selected speed. Selecting full speed will accelerate the motor smoothly until full speed is reached. Accelerating rotor contactors will operate at specific speeds.

Bringing the master controller back from full speed to one of the slower speeds or to the zero position will cause the drive torque to be removed from the motor until such time that the selected speed is achieved. If the load is light and the deceleration ramp error sufficiently large the motor will be slowed down by plugging, if the Hoist plugging parameter is set to True, otherwise the brake will close immediately as the joystick returns to Neutral.

5.4.2. Lowering With an Overhauling Load

As soon as one of the three lowering slow speeds on the master controller is selected, the THYROMAT will activate the hoist contactor which will supply voltage to the motor. A short time delay is provided before the brake is released. In an overhauling load operation, the hoist contactor remains activated, providing the motor the opportunity to apply counter-torque in order to maintain the lowering speed.

In a no-load condition the lower contactor may be energized to operate the drive mechanism against friction. When full speed lowering is requested the lower contactor closes immediately, the voltage is ramped to full voltage and the motor will accelerate to full speed.

Bringing the master controller back from full speed to one of the slower speeds will cause additional counter-torque to be applied until such time that the selected speed is achieved.

In the event that the master controller is brought back to the zero position, additional counter torque will be applied until the motor reaches zero speed and after a short time delay voltage to the motor is removed. Should counter-torque braking last for more than the time allowed by the lower plug time out parameter, the brake will be automatically applied, the voltage removed from the motor and a fault “Plugg out time” displayed on the drive.

5.4.3. Regeneration

Selecting full speed when lowering, the THYROMAT will activate the lowering contactors. Voltage is applied to the motor and after a short delay the brake is released. The motor is then driven at full speed in the lowering direction.

5.4.4. Lowering With a Light Load

The lowering operation with light loads is slightly different from the other lowering operations. As soon as one of the three lowering slow speeds on the master controller is selected, the THYROMAT will activate the hoist contactors which will supply voltage to the motor, a short delay in time is provided before the brake is released. Should the motor not move the hoist contactors will be released and the lower contactors are activated. The motor is then driven in the lowering direction until the selected speed is achieved.

If the load should become an overhauling load then the system will automatically revert to the counter torque mode. This operating principle is selected for safety reasons as the hoist contactors are always activated first. The resultant effect ensures for fail-safe operation and the effective management of the motor and brake and allows for precision placing of material loads or cargo.

5.5. TRAVEL OPERATIONS

The following paragraphs detail the operational procedures during travel operations tasks;

5.5.1. Travel In All Directions

As soon as one of the four direction speeds on the master controller is selected, the THYROMAT will activate one of the travel directional contactors that will supply power to the motor, a short delay in time is provided before the brake is released. Selection of one of the three slow speeds will regulate the motor to the associated speed, in the event that full speed is selected the motor will accelerate smoothly until full speed is achieved.

Bringing the master controller back from full speed to one of the slower speeds will cause the drive torque to be removed from the motor until such time that the selected speed is achieved. In the event that the master controller is brought back to the zero position braking torque will be applied to the motor until zero speed is reached.

If during slow speed regulation the crane begins to increase speed above the selected speed the reversing contactors will be reversed and counter torque applied until the crane's speed has reduced to the selected speed.

NOTE

Brake plugging to neutral or between notches may be disabled by the respective parameters, in this case the motor will coast to the desired speed or to stand still in the event of neutral position.

When the joystick is placed into the opposite direction of the actual crane movement, brake plugging is always applied, it can not be disabled by a parameter choice.

6 SECTION 6 : OPERATION OF CONTROL PANEL

6.1. GENERAL

The control panel of the THYROMAT controller consists of a liquid crystal display (LCD) and an eight push-button keypad. Figure 6-1 illustrates the display and keypad making up the complete panel.

The display has back lighting to aid the identification of the displayed data under darkened conditions. The back lighting can only be activated in the main menu page (after the power up cycle has completed). To activate (switch on) the back lighting press any key, the backlight will automatically go off 20 seconds later.

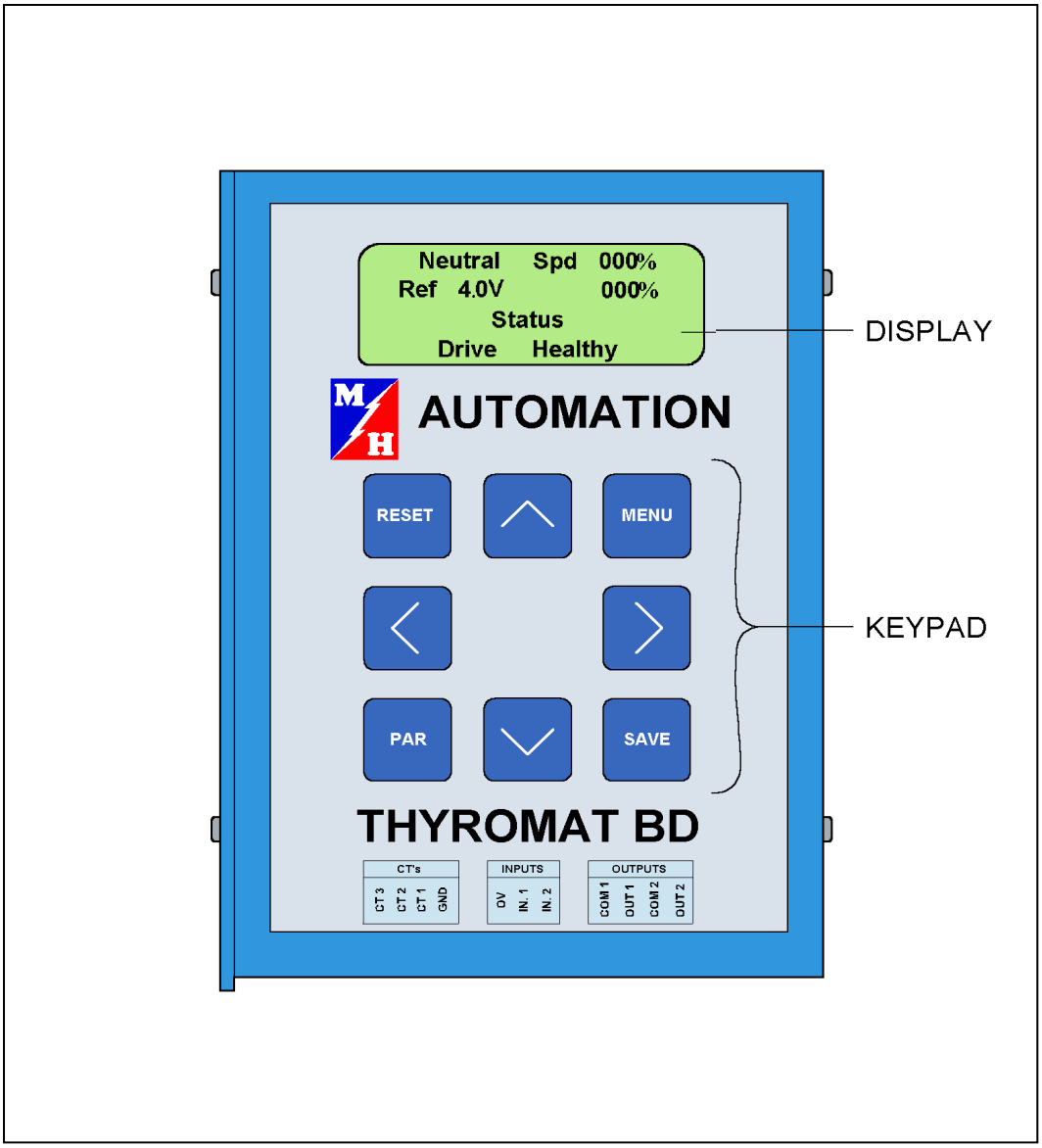


Figure 6-1 : Control Panel

The display has six main active menu display pages, each page has four lines. Table 6-1 lists the six active menu display pages with details of the four displayed lines.

Table 6-1 : Menu Display Pages

FUNCTION	LINE	DESCRIPTION	REMARKS
Power up display page	**1ST**	MH AUTOMATION	This page is displayed for 2 seconds

POWER UP PAGE	2ND	This page shows all the alphabetic letters and numbers for a period of approximately 2 seconds, followed by the software version numbers for Control Card and Panel	after power up. This page displays the type of control and software version number. During the power up delay time, the THYROMAT status relay is de-energised.
	3RD		
	4TH	C Copyright 2001	
Default display page **STATUS MONITORING PAGE**	1ST	Joystick position and speed %	The THYROMAT BD automatically displays this page after the power up delay time. To toggle between this page and the MOTOR CURRENTS page press the MENU key:- MENU
	2ND	Phase Shifter reference and Overload capacity	
	3RD	Status	
	4TH	Drive healthy (drive status)	
Second display page **MOTOR 3 PHASE CURRENTS MONITORING PAGE**	1ST	Joystick position and speed %	This page displays the current transformer inputs, take note that the reference and speed functions are also displayed. To return to STATUS MONITORING page, press the MENU key. MENU
	2ND	Phase Shifter reference and Overload capacity	
	3RD	CT1 CT2 CT3 (Current transformer input)	
	4TH	000 000 000 (Current transformer value in amperes)	

6.2. SUPPLEMENTARY DISPLAY PAGES "SCROLL MENU"

To enter this menu, press the key marked “PAR”, the typical displayed page is illustrated in figure 6-2.

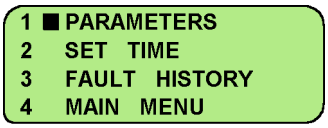


Figure 6-2 : Typical Displayed Page

Scroll up or down using the “UP” and “DOWN” keys to select the desired function.

6.2.1. Parameters

This function allows the operator to scroll through and change the settings of the pre-loaded default parameters.

Once this page has been accessed it can only be exited by pressing the “SAVE” key. When the “SAVE” key is pressed all information is saved (including any changes) and the display reverts back to the main display page.

6.2.2. Set Time

This function allows the operator to view the current time and date, and also to set the time and date.

In the event that the clock is adjusted, the real time clock will only activate once the “SAVE” key is pressed. When the “SAVE” key is pressed all information is saved (including any changes) and the display reverts back to the main display page.

6.2.3. Fault History

This function only displays the recorded faults and the date and time that the each of the faults occurred.

6.3. KEY PAD PUSH BUTTONS

The keypad of the THYROMAT BD Digital Crane Controller has eight push buttons; Table 6-2 lists the push buttons and their functions.

Table 6-2 : Keypad Push Buttons

PUSH-BUTTON	IMAGE	FUNCTION
UP		Counts, or moves the cursor, UP and DOWN respectively, dependant on which screen is active.
DOWN		
LEFT		Pages the displayed screen, or moves the cursor LEFT and RIGHT respectively.
RIGHT		
RESET		Resets the status fault(s) on the display, assuming that the fault(s) have been rectified. Also clears the fault history when in FAULT HISTORY page.
MENU		Toggles the display between DRIVE STATUS page and CURRENT MONITORING page.
PAR		Brings up the SCROLL MENU Page.
SAVE		Shows SAVING on the display if the menu displayed was the PARAMETERS or SET TIME display. Brings up the selected Menu Page if in the SCROLL MENU Page. Returns back to the SCROLL MENU Page if the menu displayed was FAULT HISTORY or MAIN MENU.

6.4. CONTROL PANEL OPERATION

Navigating through the Display, by using the Keypad, is logical and structured as detailed in figure 6-3 Menu Navigation Chart below.

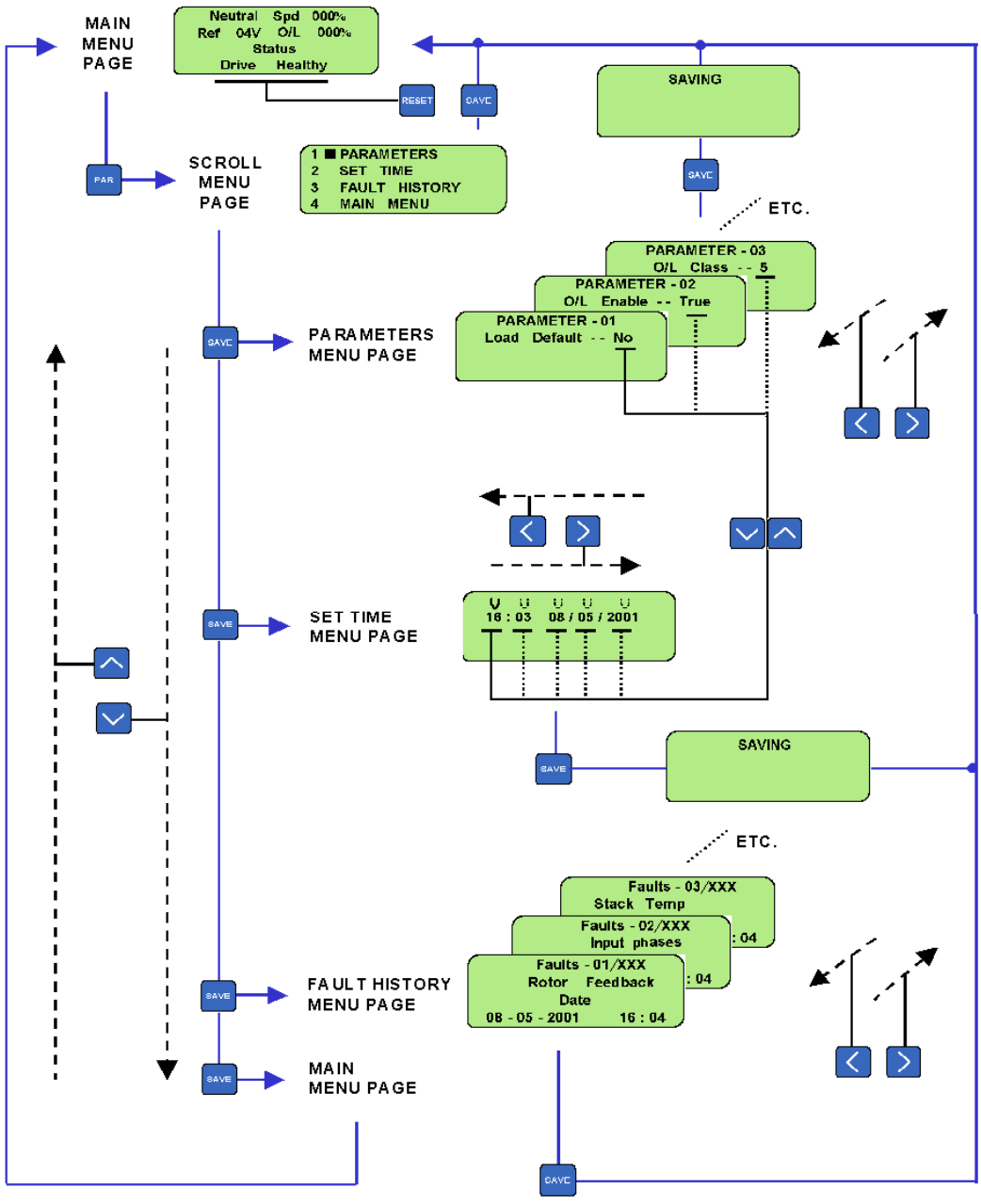


Figure 6-3 : Menu Navigation Chart

6.5. PARAMETER LISTS PAGE

6.5.1. Accessing the Parameters Page

Table 6-3 details the parameters page navigation.

Table 6-3 : Parameters Page Navigation

STEP	ACTION	DISPLAY
1	Press the “PAR” key	1 ■ PARAMETERS 2 SET TIME 3 FAULT HISTORY 4 MAIN MENU
2	Enter the password	* * * *
3	Press “SAVE” key to enter the parameters list	
4	Scroll through the parameters with < and > keys	
5	To modify a parameter scroll ^ or v to the correct value, then use the < or > keys to move to the next parameter	
6	To save the changes made to the parameters list press the “SAVE” key; this will exit the parameters list and save the changes. The display will show “SAVING” for 2 seconds.	SAVING
7	After the saving process the display will then return to the main display page.	Neutral Spd 000% Ref 4.0V O/L 000% Status Drive Healthy
8	**NOTE:** By pressing “RESET” key one can exit parameters without saving them	

6.6. SET TIME PAGE

The SET TIME page is illustrated in Figure 6-4.

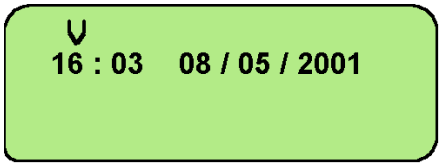


Figure 6-4 : Set Time Page

The SET TIME page displays the hour, minute, day, month and year. The cursor indicates the field which can be adjusted.

Table 6-4 lists the field name and the range.

Table 6-4 : Field and Range

FIELD	RANGE
Hour	00 to 24
Minute	00 to 59
Day	00 to 31
Month	01 to 12
Year	2000 to 2099

6.7. FAULT HISTORY

The THYROMAT stores a maximum of 254 faults in the order they appear and can be viewed by scrolling through the fault history pages. The faults are listed in the order 01 (most recent fault) to 254(the oldest fault). As a fault occurs it automatically takes position 01 and pushes all the recorded faults up one level until the oldest fault is bumped off the fault history list.

A typical fault history menu page is illustrated in figure 6-5.

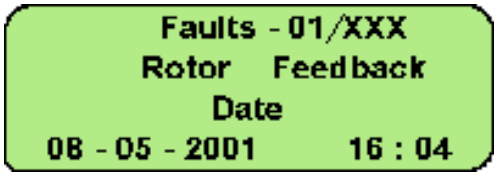


Figure 6-5 : Fault History Menu Page

The fault history data is displayed in four rows. The following details the displayed data:

- Row 1 - The system fault number
- Row 2 - The fault description
- Row 3 - The date title
- Row 4 - The date and time that that failure occurred.

Most of the faults can be reset via the master controller's neutral position (at the operator's position). To clear fault history press RESET then SAVE keys in this order and all the fault history will be cleared.

Table 6-5 lists the fault number, description, whether it can be re-set, what is been measured and possible causes.

Table 6-5 : Hoist and Travel Faults

FAULT	FAULT DESCRIPTION	HOIST	TRAVEL	REFER TO
ROTOR FDBK S	Rotor feedback loss before the brakes were released	√		6.8.1 (a)
Rotor FDBK Q1	Rotor feedback loss after releasing of brakes and during Hoisting	√		6.8.1 (b)
	Rotor feedback loss after releasing of brakes and during Forward		√	6.9.1 (b)
Rotor FDBK Q2	Rotor feedback loss after releasing of brakes and during Hoist Plugging	√		6.8.1 (c)
	Rotor feedback loss after releasing of brakes and during Forward Plugging		√	6.9.1 (c)
Rotor FDBK Q3	Rotor feedback loss after releasing of brakes and during Lowering (Drive down)	√		6.8.1 (d)
	Rotor feedback loss after releasing of brakes and during Reverse		√	6.9.1 (d)
Rotor FDBK Q4	Rotor feedback loss after releasing of brakes and during Lower Plugging or Counter Torque Lowering	√		6.8.1 (e)
	Rotor feedback loss after releasing of brakes and during Reverse Plugging		√	6.9.1 (e)
CURNT FDBK S	Current feedback loss (all 3 phases) before the brakes were released	√		6.8.2 (a)
CURNT FDBK Q1	Current feedback loss after releasing of the brakes and during Hoisting	√		6.8.2 (b)
	Current feedback loss after releasing of the brakes and during Forward		√ only when C.T's = Yes	6.9.2 (b)
CURNT FDBK Q2	Current feedback loss after releasing of the brakes and during Hoist Plugging	√		6.8.2 (c)
	Current feedback loss after releasing of the brakes and Forward Plugging		√ only when C.T.'s = YES	6.9.2 (c)
CURNT FDBK Q3	Current feedback loss after releasing of the brakes and Lowering (Drive down)	√		6.8.2 (d)
	Current feedback loss after releasing of brakes and Reverse provided C.T.'s = YES		√ only when C.T.'s = YES	6.9.2 (d)
CURNT FDBK Q4	Current feedback loss after releasing of the brakes and Lower Plugging or Counter Torque Lowering	√		6.8.2 (e)

FAULT	FAULT DESCRIPTION	HOIST	TRAVEL	REFER TO
CURNT FDBK Q4	Current Feedback loss after releasing of brakes and Reverse Plugging		√ only when C.T.'s = YES	6.9.2 (e)
CURNT LOSS 1 S CURNT LOSS 2 S CURNT LOSS 3 S	Phase current loss before the brakes were released. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3	√		6.8.3 (a)
CURNT LOSS 1 Q1 CURNT LOSS 2 Q1 CURNT LOSS 3 Q1	Phase current loss after releasing of the brakes and during Hoisting. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3	√		6.8.3 (b)
	Phase current loss after releasing of the brakes and during Forward. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3		√ only when C.T.'s = YES	6.9.3 (b)
CURNT LOSS 1 Q2 CURNT LOSS 2 Q2 CURNT LOSS 3 Q2	Phase current loss after releasing of the brakes and during Hoist Plugging. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3	√		6.8.3 (c)
	Phase current loss after releasing of the brakes and during Forward Plugging. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3		√ only when C.T.'s = YES	6.9.3 (c)
CURNT LOSS 1 Q3 CURNT LOSS 2 Q3 CURNT LOSS 3 Q3	Phase current loss after releasing of the brakes and during Lowering (Drive down) The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3	√		6.8.3 (d)
	Phase current loss after releasing of the brakes and during Reverse. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3		√ only when C.T.'s = YES	6.9.3 (d)
CURNT LOSS 1 Q4 CURNT LOSS 2 Q4 CURNT LOSS 3 Q4	Phase current loss after releasing of brakes and during Lower Plugging or Counter Torque Lowering. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3	√		6.8.3 (e)
	Phase Current loss after releasing of the brakes and during Reverse Plugging. The suffix 1; 2 or 3 refers to CT input 1; 2 or 3		√ only when C.T.'s = YES	6.9.3 (e)
CURNT UNBAL 1 S CURNT UNBAL 2 S CURNT UNBAL 3 S	A 50% discrepancy between the phase current displayed and the highest phase current reading at the time, before the brakes were released. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3	√		6.8.4 (a)
CURNT UNBAL 1 Q1 CURNT UNBAL 2 Q1 CURNT UNBAL 3 Q1	A 50% discrepancy between the phase current display and the highest phase current reading at the time, during Hoisting. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3	√		6.8.4 (b)
	A 50% discrepancy between the phase current display and the highest phase current reading at the time, during Forward. The suffix 1; 2 or 3 refers to CT input 1; 2 or 3		√ only when C.T.s = YES	6.9.4 (b)

FAULT	FAULT DESCRIPTION	HOIST	TRAVEL	REFER TO
CURNT UNBAL 1 Q2 CURNT UNBAL 2 Q2 CURNT UNBAL 3 Q2	A 50% discrepancy between the phase current display and the highest phase current reading at the time, during Hoist Plugging. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3	√		6.8.4 (c)
	A 50% discrepancy between the phase current display and the highest phase current reading at the time, during Forward Plugging. The suffix 1; 2 or 3 refers to CT input 1; 2 or 3		√ only when C.T.'s = YES	6.9.4 (c)
CURNT UNBAL 1 Q3 CURNT UNBAL 2 Q3 CURNT UNBAL 3 Q3	A 50% discrepancy between the phase current display and the highest phase current reading at the time, during Lowering (Drive down). The Suffix1; 2 or 3 refers to CT input 1; 2 or 3	√		6.8.4 (d)
	A 50% discrepancy between the phase current display and the highest phase current reading at the time, during Reverse. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3		√ only when C.T.'s = YES	6.9.4 (d)
CURNT UNBAL 1 Q4 CURNT UNBAL 2 Q4 CURNT UNBAL 3 Q4	A 50% discrepancy between the phase current display and the highest phase current reading at the time, during Lower Plugging or Counter Torque Lowering	√		6.8.4 (e)
	A 50% discrepancy between the phase current display and the highest phase current reading at the time, during Reverse Plugging. The Suffix 1; 2 or 3 refers to CT input 1; 2 or 3		√ only when C.T's = YES	6.9.4 (e)
RFB & CURNT LOSS S	Simultaneous loss of Rotor feedback and all 3 phase currents, before the brakes were released	√		6.8.5 (a)
RFB & CURNT LOSS I	Simultaneous loss of Rotor feedback and all 3 phase currents, during operation The fault was initiated firstly by the loss of all 3 phase currents, followed by the loss of Rotor feedback	√	√ only when C.T.'s = YES	6.8.5 (b)
RFB & CURNT LOSS R	Simultaneous loss of Rotor feedback and all 3 phase currents, during operation The fault was initiated firstly by the loss of Rotor feedback followed by the loss of all 3 phase currents	√	√ only when C.T.'s = YES	6.8.5 (c)
OVERCURRENT	Motor stator current (any one of the 3) is greater than 4 x motor current for a period exceeding 1.5 sec.	√	√ only when C.T.'s = TRUE	6.8.6
NOT IN NEUTRAL (Not logged in fault history)	The joystick is out of Neutral position during unit power up.	√	√	6.8.7
J ERROR (Not logged in fault	The joystick direction input is missing while notch 2; 3 or 4 are present	√	√	6.8.8

FAULT	FAULT DESCRIPTION	HOIST	TRAVEL	REFER TO
history)				
MOTOR STALL	The motor remains at standstill for 10 seconds while the RUN command is active	√	√	6.8.9
STACK TEMP	Stack over temperature. The Thermal switch mounted on the stack is in the OPEN state	√	√	6.8.10
H LOSS TORQUE	Hoist loss of torque, occurs when during Hoisting operation the motor slips to a speed >10% Lowering	√		6.8.11
LOWER OVERSPEED	The motor speed during COUNTER TORQUE LOWERING is > 130%	√		6.8.12
INPUT PHASES	A Phase Shifter fault has occurred, which may be linked to one or more of the following: - 3 Phase supply > 70% of Un - Supply single phasing - Supply phase rotation wrong	√	√	6.8.13
BRAKE RELEASE	At least one of the phase currents is below the BRAKE RELEASE CURRENT at the start during Torque proofing	√		6.8.14
DRIVE LEVEL	The minimum Phase Shifter Voltage reference determined by the Control Card is below 3,5V. The standard level is 3,8V	√	√	6.8.15
POWER ON TEST	The System goes through a complex test of the software and associated switchgear which in the event of failure The Power on Test is displayed. Usually this fault precedes another fault, which is displayed in the form of a Code number as described below.	√	√	6.8.16
CODE 100	The CPU received joystick information which is out of acceptable boundaries	√	√	6.8.17 (a)
CODE 101	CPU Watchdog reset	√	√	6.8.17 (b)
CODE 102	CPU supply voltage below the Brown out level	√	√	6.8.17 (c)
CODE 103	CPU internal loss of messages	√	√	6.8.17 (d)
CODE 104	CPU failed to read saved parameters or does not recognise the combination of parameters stored in the EEprom.			6.8.17 (e)
CODE 106	CPU – System fault. An instruction taken from the EVENT queue has no meaning within the MOTOR MODULE and it can not be processed.	√	√	6.8.17 (f)
CODE 107	This fault code was created to assist during	√	√	6.8.17 (g)

FAULT	FAULT DESCRIPTION	HOIST	TRAVEL	REFER TO
	software development phase, to trap the unnecessary logging of "CURRENT FEEDBACK" trips			
CODE 108	This fault code was created to assist during software development phase, to trap the instruction to accidental switching of both directional contactors	√	√	6.8.17 (h)
CODE 109	The fault code was created to assist during software development phase, to trap the instruction to accidentally turn off both directional contactors when one should have been switched ON.	√	√	6.8.17 (i)
HEALTHY	The logging of a "Healthy: fault, indicates that the system has tripped, but the CPU missed the reading of the Error fault stamp and the Healthy status was instead logged.	√	√	6.8.17 (j)

6.8. POSSIBLE CAUSES OF FAILURE ON HOIST SYSTEMS:

The aim of this chapter is to assist the user in getting to the cause of the fault as quick as possible, although great effort has been put into describing as many causes of faults as possible. It is almost impossible to cover every single aspect of the entire crane installation without running the risk of creating a guide, which then looks more like a technical book. The desired speed required repairing or correcting the fault would then be lost in the extensive reading and searching for the exact fault definition.

It is always far more productive for the user to become more familiar with the THYROMAT basic methods of motor control. It is possible to acquire the information from this manual as well as from specific THYROMAT courses offered at our head office as well as at certain support centres.

The following paragraphs list some possible causes of failures and the effects it may have on the operating system.

6.8.1 LOSS OF ROTOR FEEDBACK

Rotor feedback is used by the THYROMAT as the motor loop speed feedback and it is essential to the operation of the unit. In the event that this feedback is not present the unit has to trip to prevent it from falling into an unknown state.

The rotor feedback is tapped off of two of the three motor rotor phases. The unit reads the rotor frequency, which is inversely proportional to the rotor rotational speed, (i.e. directly proportional to the motor slip)

Rotor frequency = Stator frequency x motor slip.

At standstill the rotor frequency is equal to the supply frequency, which is 50 Hz, as the motor starts accelerating towards its full speed the rotor frequency decreases towards 0 Hz.

In counter torque the rotor frequency increases from 50 Hz at standstill towards 100 Hz at 100% speed, note that in counter torque the motor field rotation is opposite to the actual rotor speed rotation, hence the increase in rotor frequency output, (i.e. motor slip >1).

Possible causes

- Directional contactor failed to energize

  A rotor feedback may occur, if the control supply is not present, when a lower or hoisting command is given to the THYROMAT. Without the control voltage, the directional contactors may not be energised. Without stator voltage, there will be no rotor feedback.

  Note: A directional contactor failure is more likely to give a "RFB & CURRT LOSS" fault.

- Rotor feedback wires loose

  One or both feedback wires between the motor rotor phases and the unit terminals 17 and 18 are loose.

- Rotor feedback wires short-circuited

  Both feedback wires are short-circuited.

  Remove wires from terminals 17 and 18 and measure the resistance between them. It should have a low ohm reading. This is because of the still in circuit motor windings resistance as well as the corresponding rotor resistors on each phase.

  With the wires removed measure at the Thyromat terminals 17 and 18, this reading should be very high (Mega-ohms) it should actually start increasing during the reading time. This is due to an internal capacitor in parallel across these terminals. If the above tests show that the external wiring is in order, it is then advisable to reconnect the wires and proceed to the next test which is as follows:

  Measuring the voltage across terminals 17 & 18 while starting the motor.

  If a voltage is present it indicates that the external circuit is sending the rotor feedback signal but the THYROMAT unit is not reading it. Replace the Control Card enter the same parameters onto this card and try to run the system, if the fault persists, the problem may be related to the control box mother board, in this case it is advisable to replace the THYROMAT unit, and send the faulty one to our nearest repair centre.

6.8.1(a) ROTOR FDBK S

The fault has occurred during the Torque proving phase before the brakes were given the command to be released.
Refer to possible causes below.

6.8.1(b) ROTOR FDBK Q1

The fault occurred during Hoisting and while the system was operating in notches 1; 2 or 3.
Refer to possible causes below.
Note: Rotor feedback fault can not be detected during full speed operation, because the Rotor frequency is close to 0Hz.

6.8.1(c) ROTOR FDBK Q2

The fault occurred while the system was busy performing a Hoist plugging function.
Refer to possible causes below.

6.8.1(d) ROTOR FDBK Q3

The fault occurred during Lowering and while the system was operating in notches 1; 2 or 3 with an Empty hook.
Refer to possible causes below.

Note: Rotor feedback fault can not be detected during full speed operation, because the Rotor frequency is close to 0Hz.

6.8.1(e) ROTOR FDBK Q4

The fault occurred during Counter torque slow speed Lowering (Overhauling load) or during Lower plugging.
Refer to possible causes below.

6.8.1(f) <u>Possible causes of Rotor feedback loss</u>

(i) Hoist contactor – KM1 failed to energise.

- Loose connection on coil circuit, measure voltage across the coil.
- Interposing relay failure (when applicable), measure voltage across the coil.
- Faulty Relay Card output, measure voltage across Thyromat terminals 10 and 16. This fault may be preceeded by RFB & CURNT LOSS.

(ii) Lower contactors – KM2 failed to energise.

- Loose connection on coil circuit, measure voltage across the coil.
- Interposing relay failure (when applicable), measure voltage across the coil.
- Faulty Relay Card output, measure voltage across Thyromat terminals 10 and 15. This fault may be preceeded by RFB & CURNT LOSS.

(iii) One or both Rotor feedback wires between the motor Rotor resistance and the Thyromat terminals17 & 18 are loose.

Measure the Ohm value across the Thyromat terminals 17 & 18. The reading will be very low <5 ohms.

Warning: In some cases the multimeter reading is so low, that it can be mistaken as a short circuit of these wires, refer to (iv) below.

(iv) Rotor Feedback wires short-circuited.

To ensure that a short circuit is not the reason why the Ohm reading is low (i.e. close to 0Ω), remove one of the Rotor feedback wires from the Rotor resistance connection side, then measure the Ohm value of the circuit which now should be in the region of MΩ, and will keep on increasing due to the capacitance across the terminals.
If the reading remains close or at 0Ω then the wires are short-circuited.
If the reading is infinite, while the wires remain connected to the Thyromat terminals 17 & 18, replace the Control Card, because the damage is internal.

(v) Control Card failure

The cause of the problem may be due to a faulty Control card.
After ascertaining that the problem is not due to any of the above reasons, it is suggested that the control card is replaced with another Hoist Control Card.

Ensure that the existing parameters are entered into the new Card, if the fault persists, the problem may be caused by the following reasons:

(vi) Phase Shifter failure

Measure the voltage across the Thyromat terminals 17 & 18, while a Hoist notch 1 to 4 running

Command is given. In the event of a faulty system the trip during start of a new cycle is delayed by 2 seconds therefore the reading of any voltage signal has to be done quickly within this period.
If there was signs of voltage being present during this period the Phase Shifter may be in working order. To confirm this, the same quick reading of all three Thyromat output voltages has to be done to ensure that the Phase Shifter is working correctly. If the 3 output phases measurement proves in order, then the problem may be related to loose connections on the **motherboard**, in this case the entire unit needs replacing.

6.8.2 CURRENT FEEDBACK LOSS (All 3 phases)

Hoist applications require monitoring of all 3 motor stator currents, for the efficient and safe operation of the system, if the Drive can not read any motor currents, it will trip on a current feedback fault as described below:

6.8.2(a) CURNT FDBK S

The fault has occurred during the Torque proving phase, before the brakes were given the command to be released. Refer to possible causes below.

6.8.2(b) CURNT FDBK Q1

The fault occurred during Hoisting operation.
Refer to possible causes below.

6.8.2(c) CURNT FDBK Q2

The fault occurred during Hoisting plugging.
Refer to possible causes below.

6.8.2(d) CURNT FDBK Q3

The fault occurred during Lowering operations (Drive down mode). Empty hook notches 1; 2 or 3 or during full speed lowering.
Refer to possible causes below.

6.8.2(e) CURNT FDBK Q4

The fault occurred during Lowering plugging or slow speed lowering with an overhauling load, (i.e. counter torque lowering)
Refer to possible causes below.

6.8.2(f) Possible causes of Current feedback loss

General information on Current feedback circuit:

The current feedback circuit in the Control Card gets its 3 phase readings from 3 Current Transformers (C.T.s) installed on the Stator phases.
The signal coming out of the CTs is and AC signal <5V AC (<1 Amp).

This AC signal is then fed into the “Current converter” which converts the AC signal into a DC signal also <5V DC.

The 3 DC voltage signals are then fed into the Thyromat via the CT1; CT2 and CT3 inputs, installed on the Control Panel.

The Control Panel is only used as a “pass through” for the 3 Current signals via the Ribbon Cable

which attaches the Control Panel to the Control Card.
The entire processing of the 3 phase current measurement is done in the Control Card.

Each phase has its DC voltage reference to the Common wire (Green wire), therefore any voltage measurement has to be done between the respective CT phase input and the Common.

- The CT1 is wired to the Red wire
- The CT2 is wired to the Yellow wire
- The CT3 is wired to the Blue wire

Possible causes of Current feedback faults

General: It is assumed that the user has available a **Current Clamp** (Analogue or Digital) to assist with fault finding procedure.

- Initial steps

.1 - Press the "MENU" key on the Control Panel to change to the CTs Page.

.2 - Line 3 of the LCD display will show CT1; CT2; CT3.

.3 - Line 4 of the LCD display will show 0 Amps on all 3 phases.

.4 - Engage Hoist notch 1, if the fault still exists the contactor will remain energised for a period of 2 seconds before the "CURNT FDBK S" fault is displayed. It is during this time that the Current readings of the Current Clamp are compared with the Current readings of the Display:

.5 - If The Current clamp shows 0 Amps, obviously the display will also show 0 Amps.

.5.1 - Did the directional (Hoist) contactor energise?

- Yes: then the fault may be caused by:

a) - Ensure that all 3 phases are present at the Thyristors terminal U; V; W.

b) - Phase Shifter trigger modules, replace the Phase Shifter card.

c) - All 3 Thyristors are "OPEN CIRCUIT", replace unit.

d) - Motor Stator cable is faulty, open circuit.

e) - Motor stator windings are faulty, open circuit.

- No: then the fault may be caused by:

a) - Control supply missing, ensure that the voltage across the Thyromat control terminals 10 & 11 corresponds to the Panel control voltage.

b) - Measure voltage across the relevant directional contactor:

If the voltage is present during start up (2 sec.) then the contactor mechanism or coil is faulty.
If not present during the start up (2 sec.), then check the voltage across Thyromat terminals 10 and 15 or 10 and 16.
If there is no voltage, then replace the Relay Card.

.6 - If the Current Clamp shows a Current reading and the Hoist directional contactor is energising, but the display remains at 0 Amps the problem may be caused by a faulty current converter circuit.

- Ensure that the plug is plugged correctly

- Ensure that all 4 CT wires (Red; Yellow; Blue and Green) are connected to the plug.

- While giving a Hoist notch 1 to 4 command to the Unit measure the AC voltage out of the CTs (one at a time), these must be a voltage <5V AC at any CT, and they should be similar.
  It is unlikely that all 3 CTs are faulty simultaneously.
- Unplug the CTs plug and measure the DC voltage between Green and any of the 3 phases. While giving a Hoist notch 1 to 4 command to the unit.
  The Thyromat will trip on CURNT FDBK S after 2 seconds, so this test needs to be done several times to cover all 3 phases.

  If there is no voltage (<5VDC) at any one of the phase tests, the Current Converter is faulty and needs replacing.

  If there is voltage (<5VDC), then the problem may be the Ribbon cable that connects The Control Panel to the Control Card, or the Control Card is faulty.

  It is easier to replace the Control card first before attempting to strip open the Control Panel to remove the Ribbon cable.

6.8.3 Single Phase Current Loss

Hoist applications require monitoring of all 3 motors stator currents, for the efficient and safe operation of the system. If the drive reads one CT current at 0 Amps while the others are >0 Amps, it will trip on Current loss.

6.8.3 (a) CURNT LOSS 1 S (loss of phase 1 current)
CURNT LOSS 2 S (loss of phase 2 current)
CURNT LOSS 3 S (loss of phase 3 current)

The fault has occurred during the Torque proving phase, before the brakes were given the command to be released.
Refer to possible causes below.

6.8.3 (b) CURNT LOSS 1 Q1 (loss of phase 1 current)
CURNT LOSS 2 Q1 (loss of phase 2 current)
CURNT LOSS 3 Q1 (loss of phase 3 current)

The fault occurred during Hoisting operation.
Refer to possible causes below.

6.8.3 (c) CURNT LOSS 1 Q2 (loss of phase 1 current)
CURNT LOSS 2 Q2 (loss of phase 2 current)
CURNT LOSS 3 Q2 (loss of phase 3 current)

The fault occurred during Hoisting plugging.
Refer to possible causes below.

6.8.3 (d) CURNT LOSS 1 Q3 (loss of phase 1 current)
CURNT LOSS 2 Q3 (loss of phase 2 current)
CURNT LOSS 3 Q3 (loss of phase 3 current)

The fault occurred during Lowering operations (Drive down mode). Empty hook notches 1; 2 or 3 or during full speed lowering.
Refer to possible causes below.

6.8.3 (e) CURNT LOSS 1 Q4 (loss of phase 1 current)

CURNT LOSS 2 Q4 (loss of phase 2 current)
CURNT LOSS 3 Q4 (loss of phase 3 current)

The fault occurred during Lowering plugging or slow speed lowering with an overhauling load, (i.e. counter torque lowering).
Refer to possible causes below.

6.8.3 (f) Possible causes of Current loss 1; 2 or 3

General: It is suggested that the user reads the previous chapter 6.8.2 (f), to familiarise themselves more with current feedback readings.

- Current loss means that all 3 phases CT readings = 0 Amps
- Phase current loss means that, at least one CT reading = 0 Amps while at least another CT reading > 0 Amps.

6.8.4 Current unbalance

General: A current unbalance is only detected when at least on Phase current is <50% of the highest reading current, provided that the highest current is at least 50% of the Motor Current, the condition is validated for a period of 2 seconds at start before the brakes have been released or 800ms during operation.

6.8.4 (a) CURNT UNBAL 1 S
CURNT UNBAL 2 S
CURNT UNBAL 3 S

The fault has occurred during the Torque proving phase, before the brakes were given the command to be released.
Refer to possible causes below.

6.8.4 (b) CURNT UNBAL 1 Q1
CURNT UNBAL 2 Q1
CURNT UNBAL 3 Q1

The fault occurred during Hoisting operation.
Refer to possible causes below.

6.8.4 (c) CURNT UNBAL 1 Q2
CURNT UNBAL 2 Q2
CURNT UNBAL 3 Q3

The fault occurred during Hoisting plugging.
Refer to possible causes below.

6.8.4 (d) CURNT UNBAL 1 Q3
CURNT UNBAL 2 Q3
CURNT UNBAL 3 Q3

The fault occurred during Lowering operations (Drive down mode). Empty hook notches 1; 2 or 3 or during full speed lowering.
Refer to possible causes below.

6.8.4 (e) CURNT UNBAL 1 Q4
CURNT UNBAL 2 Q4

CURNT UNBAL 3 Q4

The fault occurred during Lowering plugging or slow speed lowering with an overhauling load, (i.e. counter torque lowering)
Refer to possible causes below.

6.8.4(f) Possible causes of Current Unbalance

- Mains supply, phase unbalance

This may be caused by a sudden drop on one phase of the Mains supply, usually such a condition is very serious and unlikely to affect The Crane only. This condition is more likely to cause an "Input phases" fault.

- Faulty Thyristor

One Thyristor is only conducting on the positive or the negative cycle, causing the current to drop by 50% on the corresponding phase.

- Faulty motor Stator windings

- Faulty motor Rotor windings or Slipring brushes.

- Faulty Rotor resistor circuit.

Either one phase is completely open circuit or in the event of the Rotor resistors being made up of resistor banks in parallel per phase, one of the parallel connections is faulty.

This is usually easy to identify by disconnecting the resistors from the Rotor windings (two phases at least) and compare the resistance value between phases.

- A Locked Rotor Test (LRT) may be able to identify the problem quickly, refer to LRT procedure elsewhere in this manual.

6.8.5 Rotor feedback and Current feedback loss

General: This fault is detected when the simultaneous loss of Rotor frequency and Stator current feedback.
The loss of both feedback signals, indicates that the motor stator is not being powered by the 3 phases via the Thyromat and the Stator reversing contactors.

The possible causes are:

- Directional reversing contactor didn't energize. Control circuit; coil or mechanism faulty.

- The Relay card is not switching the desired reversing contactor.

  - Check the presence of the control voltage between Thyromat terminals 10 & 11.
  - Check the control voltage between Thyromat terminals 10 & 16 (Hoist contactor) or terminals 10 & 15 (Lower contactor).
  - If any of these Tests prove unsuccessful replace the Relay card.

- The Phase Shifter is not triggering the 3 phase Thyristor stack.

- Check the voltage output between Uo, Vo and Wo immediately after a Hoist or Lower command.

  If there is no sign of voltage regulation (i.e. 0V), replace the Phase Shifter card.

- The Motor Stator cable is faulty and in open circuit.

  - Measure the resistance across the 3 stator phases at the Panel stator output terminals, the reading should be a low ohm reading. Confirm that the fault is on the cable and not on the motor stator windings by bridging the motor stator terminals while measuring the continuity once again. Ensure that the wire bridges are removed after the test.

- The Motor Stator windings are faulty and in open circuit.

  - If the cable test above proved successful, then the faulty open circuit may be inside the motor.
    Measure the continuity of the stator windings at the motor terminals

The RBF & CURNT LOSS will be displayed with a suffix S; I or R.

Suffix S: Indicates that the fault occurred during Torque proving, before the brakes were released.
Note: This is only applicable to Hoist motions.

Suffix I: Indicates that, the fault was caused by all 3 phase currents being at 0 Amps and during the timing out of the validation period the Rotor feedback also became 0Hz.

Suffix R: Indicates that, the fault was caused by the Rotor feedback being at 0Hz and during the timing out of the validation period all 3 phase currents also became 0 Amps.

6.8.6 Overcurrent

An Overcurrent trip is detected and logged if the Current measured on any one of the 3 phases is at least 400% higher than the Motor Current parameter value.

This fault is validated for a period of 1,5 seconds before a trip is logged.

Note: The Thyromat Overcurrent is intended as a secondary protection of overcurrent. The primary protection is based on the correct settings of the Motion Main Circuit Breaker (MCB).

The MCB recommended by MH Automation must have equivalent characteristics to the Merlin Gerin type NS with electronic trip relays type STR or Micrologic 2.0 or higher for units above 800A.

These MCBs together have fast short circuit protection (usually 10ms for a recommended 3 to 4 x Nominal current) have the ability of protecting not only the motor and cables but also the Thyromat solid state devices.
Providing that in the event of a M.C.B. trip there is sufficient cooling time before another run attempt is conducted

6.8.7 Not in Neutral

Not in neutral is a condition that can only be detected during powering up of the Thyromat unit.

The fault will remain displayed for as long as the joystick is out of Neutral position, it automatically resets itself when the joystick is returned to Neutral.

The fault is only for indication purposes and will not be logged on Fault history log page.

6.8.8 Joystick error

The joystick error message will appear on the top left hand side corner of the display when the Thyromat acknowledges the switching On of any speed notches without the presence of a directional notch, (i.e. notch 2; 3 or 4 are present without Hoist/Lowering notch 1)

- Check that the direction/speed interposing relays are switching correctly,
  if not, then the problem may be caused by a faulty joystick controller or the associated control cable.

  If the relays are switching correctly measure the voltage across the Thyromat terminals as follows:

- For a Hoist command the voltage between terminals:
  3 and 5 = 0V DC (open circuit = 9 to 10V DC)

- For a Lower command the voltage between terminal:
  3 and 4 = 0V DC (open circuit = 9 to 10V DC)
  3 and 5 = 0V DC (open circuit = 9 to 10V DC)

In the event that all voltages measured are correct, the fault may be caused by a faulty Control Card, replace the Unit card with another Hoist Control Card, enter the same parameters.

6.8.9 Motor stall

The definition of Motor stall as far as a Thyromat unit is concerned is that, after a valid RUN command (Hoist/Lowering or Forward/Reverse, any speed) the motor remained at standstill for a period greater that 10 sec, after the brakes were given the command to be released.

Possible causes of motor stall trips:

- The Brake contactors didn't energised.
  Check the Brake contactor circuit.

  Confirm that between Thyromat terminals 10 & 13 there is control voltage, when the Thyromat is supposed to be running (i.e. One directional contactor energised).

  If not: Replace Relay card
  If yes: Follow the Brake control circuit and ensure that the electrical interlock via the N.O. contacts of the reversing contactors is functioning correctly. Measure the voltage across the Brake contactor coil, if there is voltage present and the contactor is not energised, the contactor coil or its mechanism is faulty.

Other possible causes are:

- Brake thrustor or the power cable associated with it, is faulty.
- Faulty mechanical gear train

- It is possible that due to an excessive hook load or a Mains volt drop with a heavy suspended load the motor is unable to develop sufficient torque to lift the load and remains stationery with a load suspected during the attempt to Lift.
- In the case of Travels, it is common to find that a joint of rail suddenly became wide and the Travelling Wheels got stuck in the gap.

6.8.10 Stack over-temperature

The Thyromat thyristor stack has a temperature monitoring device (bi-metal strip) which goes open circuit in the event that the stack temperature reaches levels above its maximum allowed temperature. (i.e. in the region of 90 to 100ºC depending on the size of the unit).

To confirm that the Temperature switch is closed, measure the DC voltage across its terminals, for a closed switch it must be 0V DC an open switch will measure 9 to 10V DC.

6.8.11 Hoist Loss of torque

A Hoist loss of torque is detected if during a Hoist operation the hook slips downwards at a speed greater than 10%.

Possible causes:

- Main supply low during lifting of a full or close to full load.
- Rotor resistance single phasing, or open circuit.
- Stator voltage to low caused by a malfunctioning Phase shifter card
- Excessive hook load, when starting from a suspended load.

6.8.12 Lower overspeed

The Lower overspeed protection is **only effective during Lowering plugging** or **Lower slow Speed operation in counter-torque.**
If the speed of the motor exceeds 130% in the lowering direction during Quadrant 4 operation the trip is activated.

Possible causes:

- Rotor resistance open circuit, either the star point or the rotor terminals are in open circuit.
- Motor failure (Rotor windings).
- Motor Rotor cable open circuit.
- Faulty Phase shifter.

6.8.13 Input phases

The Thyromat unit Phase Shifter card measures all 3 mains supply phases and ensures that the Following conditions are met:

- Correct Phase rotation
- All 3 phases are present
- All 3 phases are above 70% of the Nominal Supply voltage.

In the event of any one of these condition being not true, the Phase shifter sends an Input phase trip signal to the Control card, which validates it for 500ms before a trip.

Possible causes:

- During commissioning the phase rotation is wrong, swap the phases again.
- Mains supply failure (low level or phase missing)
- Downshop supply conductor system faulty, due to broken joints or current collector skid damaged or worn out.
- Mains Supply cable faulty.
- Phase shifter card faulty.

To confirm that the problem is related to a Phase shifter card, replace the card and compare results.

6.8.14 Brake release

The Brake release fault will be logged in the event that at start of a Hoist/Lower command, during Torque proving, the stator current (any one of the phases) is lower than the Brake release current parameter, which is a percentage of the Motor current parameter.

Possible causes:

- The Brake release current entered in parameters is too high.
- Mains supply low, or temporarily low.
- Phase shifter faulty, not triggering properly to generate the required Brake release current.

6.8.15 Drive level

The Thyromat Control card CPU monitors the minimum voltage level given to the Phase Shifter card which by default is at 3,8V DC.

In the event that this Phase shifter reference voltage goes below 3,5V DC the fault is triggered 300 later.

Usually a Drive level fault that persists indicates a faulty Control card that needs replacing.

6.8.16 Power On test

During Power On, the Thyromat goes through a set of tests, which when not successful, causes a trip at Power Up. The Power On test may be followed by the logging of another fault (see code faults).
If the fault persists the Control Card needs replacing.

6.8.17 Code faults

General: Most of the Code faults indicate an internal Control Card fault.

When such a fault persists the Control Card needs to be replaced.

6.8.17 (a) Code 100 (Joystick corrupted messages)

The software layer which manages the joystick information, reads information which is out of acceptable boundaries.

Possible causes:

- Excessive electro magnetic interference.
- If persists, Faulty Control Card

6.8.17 (b) Code 101 (CPU watchdog Reset)

The CPU stopped the tick of the internal watchdog.

Possible causes:

- Excessive electro magnetic interference
- If persists, Faulty Control Card

6.8.17 (c) Code 102 (CPU voltage brown out level reached)

The CPU brown out voltage was reached.

Possible causes:

- Thyromat 10V or 5V DC supply lines dropped.
- If persists, Faulty Control Card

6.8.17 (d) Code 103 (CPU loss of software messages)

The software code compares messages received for execution with the final execution of the Actual messages (instructions), any out of synchronization of the above causes such fault code

to be active.

Possible causes:

- Excessive electro magnetic interference
- If persists, Faulty Control Card

6.8.17 (e) Code 104 (CPU failed to read valid EEprom parameters)

Possible causes:

This fault usually occurs when the Control Card is initially loaded with software, during manufactory phase.
The simple loading of default or any other parameters combination will clear the fault.

If the fault persists, the EEprom is probably damaged and the Control Card needs replacing .

6.8.17(f) Code 106 (CPU – System fault)

The CPU can not process the information received, because it has no meaning in the software "MOTOR MODULE".

Possible causes:

- Excessive electro magnetic interference
- If persists, Fault Control Card

6.8.17 (g) Code 107 (indicates an internal logging of an unrecognised fault error)

Possible causes:

- The persistence of this fault code may indicate a particular condition, possibly unique to the specific motion which causes a fault error, which trips the Thyromat, but it is not recognized by the error log table.

6.8.17 (h) Code 108 (Indicates an internal software command to switch on both reversing contactors simultaneously)

Possible causes:

- The persistence of this fault code may indicate a particular condition, possibly unique to the specific motion which causes a fault error, which trips the Thyromat, but it is not recognised by the error log table.

6.8.17 (i) Code 109 (Indicates an internal software command to switch off both reversing contactors when one should have been switched ON)

Possible causes:

- The persistence of this fault code may indicate a particular condition, possibly unique to the specific motion which causes a fault error, which trips the Thyromat, but it is not recognised by the error log table.

6.8.18 Healthy

The logging of a Healthy fault, is not a serious event, but if persists it indicates that the unit had a fault to be reported but missed the reading of the fault Error stamp during fault logging:

Possible causes:

- Excessive electro magnetic interference
- If persists, Fault Control Card

6.9 POSSIBLE CAUSES OF FAILURE ON TRAVEL SYSTEMS:

The aim of this chapter is to assist the user in getting to the cause of the fault as quick as possible, although great effort has been put into describing as many causes of faults as possible. It is almost

impossible to cover every single aspect of the entire crane installation without running the risk of creating a guide, which then looks more like a technical book. The desired speed required repairing or correcting the fault would then be lost in the extensive reading and searching for the exact fault definition.

It is always far more productive for the user to become more familiar with the THYROMAT basic methods of motor control. It is possible to acquire the information from this manual as well as from specific THYROMAT courses offered at our head office as well as at certain support centres.

The following paragraphs list some possible causes of failures and the effects it may have on the operating system.

6.9.1 LOSS OF ROTOR FEEDBACK

Rotor feedback is used by the THYROMAT as the motor loop speed feedback and it is essential to the operation of the unit. In the event that this feedback is not present the unit has to trip to prevent it from falling into an unknown state.

The rotor feedback is tapped off of two of the three motor rotor phases. The unit reads the rotor frequency, which is inversely proportional to the rotor rotational speed, (i.e. directly proportional to the motor slip)

Rotor frequency = Stator frequency x motor slip.

At standstill the rotor frequency is equal to the supply frequency, which is 50 Hz, as the motor starts accelerating towards its full speed the rotor frequency decreases towards 0 Hz.

In counter torque the rotor frequency increases from 50 Hz at standstill towards 100 Hz at 100% speed, note that in counter torque the motor field rotation is opposite to the actual rotor speed rotation, hence the increase in rotor frequency output, (i.e. motor slip >1).

Possible causes

- Directional contactor failed to energize

  A rotor feedback may occur, if the control supply is not present, when a lower or hoisting command is given to the THYROMAT. Without the control voltage, the directional contactors may not be energised. Without stator voltage, there will be no rotor feedback.

  Note: A directional contactor failure is more likely to give a “RFB & CURRT LOSS” fault.

- Rotor feedback wires loose

  One or both feedback wires between the motor rotor phases and the unit terminals 17 and 18 are loose.

- Rotor feedback wires short-circuited

  Both feedback wires are short-circuited.

  Remove wires from terminals 17 and 18 and measure the resistance between them. It should have a low ohm reading. This is because of the still in circuit motor windings resistance as well as the corresponding rotor resistors on each phase.

  With the wires removed measure at the Thyromat terminals 17 and 18, this reading should be very high (Mega-ohms) it should actually start increasing during the reading time. This is due to an internal capacitor in parallel across these terminals. If the above tests show that the external wiring is in order, it is then advisable to reconnect the wires and proceed to the next test which is as follows:

Measuring the voltage across terminals 17 & 18 while starting the motor.

If a voltage is present it indicates that the external circuit is sending the rotor feedback signal but the THYROMAT unit is not reading it. Replace the Control Card enter the same parameters onto this card and try to run the system, if the fault persists, the problem may be related to the control box mother board, in this case it is advisable to replace the THYROMAT unit, and send the faulty one to our nearest repair centre.

6.9.1(a) ROTOR FDBK S

Not applicable to Travel motions.

6.9.1(b) ROTOR FDBK Q1

The fault occurred during Forward motion and while the system was operating in notches 1; 2 or 3.
Note: Rotor feedback fault can not be detected during full speed operation, because the Rotor frequency is close to 0Hz.

6.9.1(c) ROTOR FDBK Q2

The fault occurred while the system was busy performing a Forward plugging function.

6.9.1(d) ROTOR FDBK Q3

The fault occurred during Reverse motion and while the system was operating in notches 1; 2 or 3.
Refer to possible causes below.
Note: Rotor feedback fault can not be detected during full speed operation, because the Rotor frequency is close to 0Hz.

6.9.1(e) ROTOR FDBK Q4

The fault occurred during Reverse plugging.
Refer to possible causes below.

6.9.1(f) <u>Possible causes of Rotor feedback loss</u>

(i) Forward contactor – KM1 failed to energise.

- Loose connection on coil circuit, measure voltage across the coil.
- Interposing relay failure (when applicable), measure voltage across the coil.
- Faulty Relay Card output, measure voltage across Thyromat terminals 10 and 15.
  This fault may be preceeded by RFB & CURNT LOSS.

(ii) Reverse contactors – KM2 failed to energise.

- Loose connection on coil circuit, measure voltage across the coil.
- Interposing relay failure (when applicable), measure voltage across the coil.
- Faulty Relay Card output, measure voltage across Thyromat terminals 10 and 16.
  This fault may be preceded by RFB & CURNT LOSS.

(iii) One or both Rotor feedback wires between the motor Rotor resistance and the Thyromat terminals 17 & 18 are loose.

Measure the Ohm value across the Thyromat terminals 17 & 18. The reading will be very low <5 ohms.

Warning: In some cases the multimeter reading is so low, that it can be mistaken with a short circuit of these wires, refer to (iv) below.

(iv) Rotor Feedback wires short-circuited.

To ensure that a short circuit is not the reason why the Ohm reading is low (i.e. close to 0Ω), remove one of the Rotor feedback wires from the Rotor resistance connection side, then measure the Ohm value of the circuit which now should be in the region of MΩ, and will keep on increasing due to the capacitance across the terminals.
If the reading remains close or at 0Ω then the wires are short-circuited.
If the reading is infinite, while the wires remain connected to the Thyromat terminals 17 & 18, Replace the Control Card, because the damage is internal.

(v) Control Card failure

The cause of the problem may be due to a faulty Control card.
After ascertaining that the problem is not due to any of the above reasons, it is suggested that the control card is replaced with another Hoist Control Card.

Ensure that the existing parameters are entered into the new Card, if the fault persists, the problem may be caused by the following reasons:

(vi) Phase Shifter failure

Measure the voltage across the Thyromat terminals 17 & 18, while a Hoist notch 1 to 4 running Command is given. In the event of a faulty system the trip during start of a new cycle is delayed by 2 seconds therefore the reading of any voltage signal has to be done quickly within this period. If there was signs of voltage being present during this period the Phase Shifter may be in working order. To confirm this, the same quick reading of all three Thyromat output voltages has to be done to ensure that the Phase Shifter is working correctly. If the 3 output phases measurement proves in order, then the problem may be related to loose connections on the **motherboard**, in this case the entire unit needs replacing.

6.9.2 CURRENT FEEDBACK LOSS (All 3 phases) (Applicable only if CTs enable = Yes)

Travel applications do not necessarily require monitoring of all 3 motor stator currents, for the efficient and safe operation of the system, if the Drive can not read any motor currents, it will trip on a current feedback fault as described below:

6.9.2(a) CURNT FDBK S

Not applicable to Travel motions.

6.9.2(b) CURNT FDBK Q1

The fault occurred during Forward operation.
Refer to possible causes below.

6.9.2(c) CURNT FDBK Q2

The fault occurred during Forward plugging.
Refer to possible causes below.

6.9.2(d) CURNT FDBK Q3

The fault occurred during Reverse operation.
Refer to possible causes below.

6.9.2(e) CURNT FDBK Q4

The fault occurred during Reverse plugging.
Refer to possible causes below.

6.9.2(f) Possible causes of Current feedback loss

General information on Current feedback circuit:

The current feedback circuit in the Control Card gets its 3 phase readings from 3 Current Transformers (C.T.s) installed on the Stator phases.
The signal coming out of the CTs is and AC signal <5V AC (<1 Amp).

This AC signal is then fed into the "Current converter" which converts the AC signal into a DC signal also <5V DC.

The 3 DC voltage signals are then fed into the Thyromat via the CT1; CT2 and CT3 inputs, installed on the Control Panel.

The Control Panel is only used as a "pass through" for the 3 Current signals via the Ribbon Cable which attaches the Control Panel to the Control Card.
The entire processing of the 3 phase current measurement is done in the Control Card.

Each phase has its DC voltage reference to the Common wire (Green wire), therefore any voltage measurement has to be done between the respective CT phase input and the Common.

- The CT1 is wired to the Red wire
- The CT2 is wired to the Yellow wire
- The CT3 is wired to the Blue wire

Possible causes of Current feedback faults

General: It is assumed that the user has available a **Current Clamp** (Analogue or Digital) to assist with fault finding procedure.

- Initial steps

.1 - Press the "MENU" key on the Control Panel to change to the CTs Page.

.2 - Line 3 of the LCD display will show CT1; CT2; CT3.

.3 - Line 4 of the LCD display will show 0 Amps on all 3 phases.

.4 - Engage Hoist notch 1, if the fault still exists the contactor will remain energised for a period of
2 seconds before the "CURNT FDBK S" fault is displayed. It is during this time that the Current readings of the Current Clamp are compared with the Current readings of the Display:

.5 - If The Current clamp shows 0 Amps, obviously the display will also show 0 Amps.

.5.1 - Did the directional (Hoist) contactor energise?

- Yes: then the fault may be caused by:

a) - Ensure that all 3 phases are present at the Thyristors terminal U; V; W.

b) - Phase Shifter trigger modules, replace the Phase Shifter card.

c) - All 3 Thyristors are “OPEN CIRCUIT”, replace unit.

d) - Motor Stator cable is faulty, open circuit.

e) - Motor stator windings are faulty, open circuit.

- No: then the fault may be caused by:

a) - Control supply missing, ensure that the voltage across the Thyromat control terminals 10 & 11 corresponds to the Panel control voltage.
b) - Measure voltage across the relevant directional contactor:

If the voltage is present during start up (2 sec.) then the contactor mechanism or coil is faulty.
If not present during the start up (2 sec.), then check the voltage across Thyromat terminals 10 and 15 or 10 and 16.
If there is no voltage, then replace the Relay Card.

.6 - If the Current Clamp shows a Current reading and the Hoist directional contactor is energising, but the display remains at 0 Amps the problem may be caused by a faulty current converter circuit.

- Ensure that the CT plug is plugged correctly

- Ensure that all 4 CT wires (Red; Yellow; Blue and Green) are connected to the plug.

- While giving a Forward or Reverse notch 1 to 4 command to the Unit measure the AC voltage out of the CTs (one at a time), these must be a voltage <5V AC at any CT, and they should be similar.
It is unlikely that all 3 CTs are faulty simultaneously.

- Unplug the CTs plug and measure the DC voltage between Green and any of the 3 phases. While giving a Hoist notch 1 to 4 command to the unit.
The Thyromat will trip on CURNT FDBK S after 2 seconds, so this test needs to be done several times to cover all 3 phases.

If there is no voltage (<5VDC) at any one of the phase tests, the Current Converter is faulty and needs replacing.

If there is voltage (<5VDC), then the problem may be the Ribbon cable that connects The Control Panel to the Control Card, or the Control Card is faulty.

It is easier to replace the Control card first before attempting to strip open the Control Panel to remove the Ribbon cable.

6.9.3 Single Phase Current Loss (Applicable only if CT enable = Yes)

Travel applications do not necessarily require monitoring of all 3 motors stator currents, for the efficient and safe operation of the system. If the drive reads one CT current at 0 Amps while the others are >0 Amps, it will trip on Current loss.

6.9.3 (a) CURNT LOSS 1 S (loss of phase 1 current)
CURNT LOSS 2 S (loss of phase 2 current)
CURNT LOSS 3 S (loss of phase 3 current)

Not applicable in Travel motion applications.

6.9.3 (b) CURNT LOSS 1 Q1 (loss of phase 1 current)
CURNT LOSS 2 Q1 (loss of phase 2 current)
CURNT LOSS 3 Q1 (loss of phase 3 current)

The fault occurred during Forward operation.
Refer to possible causes below.

6.9.3 (c) CURNT LOSS 1 Q2 (loss of phase 1 current)
CURNT LOSS 2 Q2 (loss of phase 2 current)
CURNT LOSS 3 Q2 (loss of phase 3 current)

The fault occurred during Forward plugging.
Refer to possible causes below.

6.9.3 (d) CURNT LOSS 1 Q3 (loss of phase 1 current)
CURNT LOSS 2 Q3 (loss of phase 2 current)
CURNT LOSS 3 Q3 (loss of phase 3 current)

The fault occurred during Reverse operations.
Refer to possible causes below.

6.9.3 (e) CURNT LOSS 1 Q4 (loss of phase 1 current)
CURNT LOSS 2 Q4 (loss of phase 2 current)
CURNT LOSS 3 Q4 (loss of phase 3 current)

The fault occurred during Reverse plugging.
Refer to possible causes below.

6.9.3 (f) Possible causes of Current loss 1; 2 or 3

General: It is suggested that the user reads the previous chapter 6.9.2 (f), to familiarise themselves more with current feedback readings.

- Current loss means that all 3 phases CT readings = 0 Amps
- Phase current loss means that, at least one CT reading = 0 Amps while at least another CT reading > 0 Amps.

6.9.4 Current unbalance (Available only when CTs enable = Yes)

General: A current unbalance is only detected when at least on Phase current is <50% of the highest reading current, provided that the highest current is at least 50% of the Motor Current, the condition is validated for a period of 2 seconds at start before the brakes have been released or 800ms during operation.

6.9.4 (a) CURNT UNBAL 1 S
CURNT UNBAL 2 S
CURNT UNBAL 3 S

Not applicable to Travel motions.

6.9.4 (b) CURNT UNBAL 1 Q1
CURNT UNBAL 2 Q1
CURNT UNBAL 3 Q1

The fault occurred during Forward operation.
Refer to possible causes below.

6.9.4 (c) CURNT UNBAL 1 Q2
CURNT UNBAL 2 Q2
CURNT UNBAL 3 Q3

The fault occurred during Forward plugging.
Refer to possible causes below.

6.9.4 (d) CURNT UNBAL 1 Q3
CURNT UNBAL 2 Q3
CURNT UNBAL 3 Q3

The fault occurred during Reverse operations.
Refer to possible causes below.

6.9.4 (e) CURNT UNBAL 1 Q4
CURNT UNBAL 2 Q4
CURNT UNBAL 3 Q4

The fault occurred during Reverse plugging.
Refer to possible causes below.

6.9.4(f) Possible causes of Current Unbalance

- Mains supply, phase unbalance

This may be caused by a sudden drop on one phase of the Mains supply, usually such a condition is
very serious and unlikely to affect The Crane only.
This condition is more likely to cause an “Input phases” fault.

- Faulty Thyristor

One Thyristor is only conducting on the positive or the negative cycle, causing the current to drop by
50% on the corresponding phase.

- Faulty motor Stator windings

- Faulty motor Rotor windings or Slipring brushes.

- Faulty Rotor resistor circuit.

Either one phase is completely open circuit or in the event of the Rotor resistors being made up of resistor banks in parallel per phase, one of the parallel connections is faulty.

This is usually easy to identify by disconnecting the resistors from the Rotor windings (two phases at least) and compare the resistance value between phases.

- A Locked Rotor Test (LRT) may be able to identify the problem quickly, refer to LRT procedure elsewhere in this manual.

6.9.5 Rotor feedback and Current feedback loss (Available only when CTs enable = Yes)

General: This fault is detected when the simultaneous loss of Rotor frequency and Stator current feedback. The loss of both feedback signals, indicates that the motor stator is not being powered by the 3 phases via the Thyromat and the Stator reversing contactors.

The possible causes are:

- Directional reversing contactor didn't energize. Control circuit; coil or mechanism faulty.
- The Relay card is not switching the desired reversing contactor.
    - Check the presence of the control voltage between Thyromat terminals 10 & 11.
    - Check the control voltage between Thyromat terminals 10 & 16 (Reverse contactor) or terminals 10 & 15 (Forward contactor).
    - If any of these Tests prove unsuccessful replace the Relay card.
- The Phase Shifter is not triggering the 3 phase Thyristor stack.
    - Check the voltage output between Uo, Vo and Wo immediately after a Hoist or Lower command.

      If there is no sign of voltage regulation (i.e. 0V), replace the Phase Shifter card.
- The Motor Stator cable is faulty and in open circuit.
    - Measure the resistance across the 3 stator phases at the Panel stator output terminals, the reading should be a low ohm reading. Confirm that the fault is on the cable and not on the motor stator windings by bridging the motor stator terminals while measuring the continuity once again. Ensure that the wire bridges are removed after the test.
- The Motor Stator windings are faulty and in open circuit.
    - If the cable test above proved successful, then the faulty open circuit may be inside the motor.
      Measure the continuity of the stator windings at the motor terminals

The RBF & CURNT LOSS will be displayed with a suffix S; I or R.

Suffix S: Indicates that the fault occurred during Torque proving, before the brakes were released.
Note: This is only applicable to Hoist motions.

Suffix I: Indicates that, the fault was caused by all 3 phase currents being at 0 Amps and during the timing out of the validation period the Rotor feedback also became 0Hz.

Suffix R: Indicates that, the fault was caused by the Rotor feedback being at 0Hz and during the timing out of the validation period all 3 phase currents also became 0 Amps.

6.9.6 Overcurrent

Refer to 6.8.6

6.9.7 Not in Neutral

Refer to 6.8.7

6.9.8 Joystick error

Refer to 6.8.8

6.9.9 Motor stall

Refer to 6.8.9

6.9.10 Stack over-temperature

Refer to 6.8.10

6.9.11 Hoist Loss of torque

Not applicable to Travel motions.

6.9.12 Lower overspeed

Not applicable to Travel motions.

6.9.13 Input phases

Refer to 6.8.13

6.9.14 Brake release

Not applicable to Travel motions.

6.9.15 Drive level

Refer to 6.8.15

6.9.16 Power On test

Refer to 6.8.16

6.9.17 Code faults

Refer to 6.8.17 for a description of these fault codes.

6.9.18 Healthy

The logging of a Healthy fault, is not a serious event, but if persists it indicates that the unit had a fault to be reported but missed the reading of the fault Error stamp during fault logging:

Possible causes:

- Excessive electro magnetic interference
- If persists, Fault Control Card

7 SECTION 7 : MAINTENANCE

7.1. GENERAL

Digital technology is a reliable alternative to analogue systems and it usually does not require maintenance intense tasks. The reliability of the Digital Thyromat Controller ensures that preventative and corrective maintenance is minimal. Maintenance is simplified and equipment down times greatly reduced due to the modular design of the THYROMAT. Added features such as Monitoring / Fault History assists the user in accurately identifying failures / faulty components within a short period of time with confidence.

It is recommended that the user retains a complete THYROMAT control unit to be used as spares. The simplistic design of the unit and the mounting procedures does not require specialised knowledge. The ease at which faulty components / units can be replaced will greatly reduce equipment down times.

A second option would be to keep a spare set of modules for the THYROMAT. The identification and replacement of faulty cards require a suitably qualified person to carry out the task. The cards have voltage sensitive devices that can be damaged if handled incorrectly.

7.2 PREVENTATIVE MAINTENANCE

Because of the design of the THYROMAT there are no preventative maintenance tasks required. Preventative maintenance may be required for the associated equipment, that depends on the various associated equipment and the applicable manufacturer's specifications.

7.2.1 Brakes

CAUTION

NEVER ASSUME THAT THE MECHANICAL BRAKE IS CORRECTLY SET. INCORRECT SETTINGS CAN LEAD TO FAILURE AND CAN CAUSE DAMAGE TO PROPERTY AND FATAL INJURIES.

One item that is critical to the safety and operation of the THYROMAT is the serviceability of the mechanical brake.

It is important that the mechanical brake is set in such a manner that it will stop a full load without motor assistance.

The mechanical brake must be checked at regular intervals.

7.2.2 Ultimate Limit Switch

CAUTION

ALWAYS CHECK THE ULTIMATE LIMIT SWITCH FOR CORRECT OPERATION ACCORDING TO THE RELEVANT REGULATIONS.

It is important that the ultimate limit switch operates to within the tolerances specified by the applicable regulations.

7.3 CRANE MAINTENANCE CHECK LIST FOR THYROMAT SYSTEM CONTROL

A. General equipment

- Check the following items

Item	Visual inspection or test	Note
a) Motors	❖ Terminal ❖ Slip ring compartment	➢ Ensure that terminal bolts are tightened ➢ The following need to be done • Brushes inspection • Slip rings smoothness visual inspection • Clean carbon developed from brushes
b) Load test	❖ Full load test	➢ To be done on basis as described by OSHACT
c) Locked rotor test to be done if there is doubt with regard to the performance of the motor	❖ Open locked rotor test	➢ Follow the following steps: • Open star point of the resistors • Disconnect brake signal from terminal-13 on the Thyromat • Hoist first notch • Ensure that motor shaft is not turning • Measure the stator voltage and rotor voltage which will correspond to the motor name plate voltages details (allow 10% variation) • Measure stator current and rotor current. Rotor current suppose to be zero or else find the fault • The readings should be fairly balanced on all three phases • The above test is done to confirm the ratio between stator and rotor voltages
	❖ Closed locked rotor test	➢ Follow the following steps: • Connect star point of the resistors • Disconnect brake signal from terminal-13 on the Thyromat • Hoist first notch • Ensure that motor shaft is not turning

		• Measure the stator voltage and rotor voltage • Measure stator current and rotor current • The readings should be fairly balanced on all three phases • Rotor voltage multiply by rotor current divide by 605 should be equal or +/- 10% to the nominal kilowatt rating of the motor if not consult MH Automation Power kW = rotor voltage x rotor current / 605

B. Protective panel

- Check the following items

Item	Visual inspection or test	Note
a) Circuit breaker	❖ Circuit breaker type ❖ Current settings	➢ See drawings for the details ➢ See drawings for the details
b) Main contactor	❖ Contact tips ❖ Mechanical damage	➢ The protective panel main contactor is a contactor that under normal working conditions it should not break heavy currents or have many mechanical operations, in the events that one or both of the above (contact tips having excessive burns or mechanical damage) are happening, perform a thorough investigation
c) Main hoist final limit switch TEST	❖ Operation	➢ By-pass hoist limit, hoist in slow speed till it trips main contactor, if not, look for the fault before handing over crane to the crane driver
d) Auxiliary hoist final limit switch TEST	❖ Operation	➢ By-pass hoist limit, hoist in slow speed till it trips main contactor, if not, look for the fault before handing over crane to the crane driver
e) Connections	❖ Loose connections	➢ Check all major power connections

C. Hoist Motion Panel

- Check the following items

Note: Same procedure for all the Hoist motion

Item	Visual inspection or test	Note
a) Circuit breaker	❖ Circuit breaker type ❖ Current settings	➢ See drawings for the details ➢ See drawings for the details
b) Reverse contactors	❖ Contact tips	➢ Thyromat switching of the directional contactors is done at zero current;

		therefore there should be minimal signs of arcing on contact tips. If this is not the case, there may be a problem with the wrong setting of phase shifter On and Off time parameters. Main causes of arcing are: • Intermittent wiring fault • Contactors have a slow switching action due to excessive wear or dust • Wrong phase shifter On and (or) Off time settings
	❖ Mechanical wear	➢ With time the contactors will mechanically worn out and they will need to be replaced, usually these contactors are capable of performing $5x10^6$ to $10x10^6$ operations depending on the current rating and manufacturer, this should be determined and preventive maintenance done to avoid the unexpected stoppages due to contactor failure. A crane working 24 hours a day 365 days a year with 300 starts/hour should have its directional contactors replaced every two years ($5x10^6$) or four years ($10x10^6$)
	❖ Auxiliary contact blocks	➢ If damaged replace
	❖ Mechanical interlock	➢ If damaged replace
c) Rotor contactors	❖ Contact tips	➢ Thyromat switching of the rotor contactors is done at the correct rotor frequency minimizing the effect of high closing currents, these contactors are not protected by zero current switching as the directional contactors are, but they do not switch open inductive loads since the resistance is always in the circuit.
	❖ Mechanical wear	➢ These contactors have a similar life span the directional contactors have but under normal conditions operates only at 60% of the operations of directional contactors, which means that its life span on the same crane can be extended by a factor of 1.5, when compared to the directional contactors.
d) Thyromat unit	❖ Stack fan ❖ Parameters ❖ Control panel ❖ Thyromat control ❖ Fault history	➢ Ensure that the fan is running ➢ To be the same as written list parameters ➢ Ensure that is not loose ➢ Ensure that Thyromat is working according to the user manual specification ➢ Analyze faults and find out why they are happening Refer to chapter 6 for assistance
e) Control limit switch	❖ Operation	➢ Ensure that Hoist is operating within boundaries of the limit switch
f) Connections	❖ Loose	➢ Same as Protective panel e)

	connections	
g) Current converter	❖ Input (R, S & T phases) continuity test ❖ Output (red, yellow and blue phases) continuity test	➢ Follow the steps below using Fluke: • Measure between brown and blue wires while they are disconnected from CT • Use diode scale • Reading should be approximately **0.9** ➢ Follow the steps below using Fluke • Measure between green (common) and red phase, yellow phase and blue phase • Reading should be approximately **0.7**

D. Travel Motion Panel

- Check the following items

Note: Same procedure for all the Travel motion

Item	Visual inspection or test	Note
a) Circuit breaker	❖ Circuit breaker type ❖ Current settings	➢ See drawings for the details ➢ See drawings for the details
b) Reverse contactors	❖ Contact tips ❖ Mechanical wear ❖ Auxiliary contact blocks ❖ Mechanical interlock	➢ Thyromat switching of the directional contactors is done at zero current; therefore there should be minimal signs of arcing on contact tips. If this is not the case, there may be a problem with the wrong setting of phase shifter On and Off time parameters. Main causes of arcing are: • Intermittent wiring fault • Contactors have a slow switching action due to excessive wear or dust • Wrong phase shifter On and (or) Off time settings ➢ With time the contactors will mechanically worn out and they will need to be replaced, usually these contactors are capable of performing $5x10^6$ to $10x10^6$ operations depending on the current rating and manufacturer, this should be determined and preventive maintenance done to avoid the unexpected stoppages due to contactor failure. A crane working 24 hours a day 365 days a year with 300 starts/hour should have its directional contactors replaced every two years ($5x10^6$) or four years ($10x10^6$) ➢ If damaged replace ➢ If damaged replace
c) Rotor contactors	❖ Contact tips	➢ Thyromat switching of the rotor contactors is done at the correct rotor frequency

	❖ Mechanical wear	minimizing the effect of high closing currents, these contactors are not protected by zero current switching as the directional contactors are, but they do not switch open inductive loads since the resistance is always in the circuit. ➢ These contactors have a similar life span the directional contactors have but under normal conditions operates only at 60% of the operations of directional contactors, which means that its life span on the same crane can be extended by a factor of 1.5, when compared to the directional contactors.
d) Thyromat unit	❖ Stack fan ❖ Parameters ❖ Control panel ❖ Thyromat control ❖ Fault history	➢ Ensure that the fan is running ➢ To be the same as written list parameters ➢ Ensure that is not loose ➢ Ensure that Thyromat is working according to the user manual specification ➢ Analyze faults and find out why they are happening Refer to chapter 6 for assistance
g) Control limit switch	❖ Operation	➢ Ensure that Cross Travel is operating within boundaries of the limit switch
h) Connections	❖ Loose connections	➢ Same as Protective panel e)
i) Current converter	❖ Input (R, S & T phases) continuity test ❖ Output (red, yellow and blue phases) continuity test	➢ Follow the steps below using Fluke: • Measure between brown and blue wires while they are disconnected from CT • Use diode scale • Reading should be approximately **0.9** ➢ Follow the steps below using Fluke • Measure between green (common) and red phase, yellow phase and blue phase • Reading should be approximately **0.7**

7.4. SPARE PARTS LIST

Category	Code	Description	Mechanical size	Model
Control box cards	OA 1050H[1)]	Hoist control card	All	BDH 25[2)] to BDH 2000[2)]
	OA 1050T[1)]	Travel control card	All	BDT 25[2)] to BDT 2000[2)]
	OA 0020[2)]	Phase shifter card	All	BD[3)] 25[2)] to BD[3)] 2000[2)]
	OA 1070[4)]	Relay control card	All	BD[3)] 25[2)] to BD[3)] 2000[2)]
	OA 0022	Snubber card	All	BD[3)] 25[2)] to BD[3)] 2000[2)]
	AO 14901	Mother board	All	BD[3)] 25[2)] to BD[3)] 2000[2)]
	OA 1080[3)5)]	Control panel card	All	BD[3)] 25[2)] to BD[3)] 2000[2)]

[1] Indicates control card software version. Replace with code e.g. **CCV5.01**

[2] Indicates supply voltage. Replace with
"A" = 220 volt
"B" = 380 volt
"C" = 400 volt
"D" = 415 volt
"E" = 460 volt
"F" = 525 volt
"G" = 550 volt
"H" = 575 volt
"I" = 320 volt
"J" = 110 volt

[3] Indicates motion. Replace with
"H" = Hoist control
"T" = Travel control

[4] Indicates control voltage. Replace with
"A" = 110 volt
"B" = 220 volt

[5] Indicates control panel software version. Replace with code e.g. CPHV5.01

Category	Code	Description	Mechanical size	Model
Thyristors[6]	SKKT106[6]	Thyristor semi-pack	M100	BD[3] 25[2] to BD[3] 60[2]
	SKKT162[6]	Thyristor semi-pack	M150	BD[3] 100[2] to BD[3] 150[2]
	SKKT162[6]	Thyristor semi-pack	M350	BD[3] 200[2]
	SKKT250[6]	Thyristor semi-pack	M350	BD[3] 350[2]
	SKKT340[6]	Thyristor disk	M500	BD[3] 400[2]
	SKKT1200[6]	Thyristor disk	M1000	BD[3] 500[2] to BD[3] 1000[2]
	N980[6]	Thyristor disk	M2000	BD[3] 1200[2] to BD[3] 2000[2]
[6] Indicates peak inverse voltage (PIV). For supply voltage 110 volts to 415 volts replace with "16" For supply voltage 525 volts replace with "18" **Note** : 16 = 1600 volt 18 = 1800 volt Note **The Thyristors listed will in all cases be suitable as spares but installed thyristors may not necessary be the same.**				
Fans	M150 fan[4]	Compact fan	M150	BD[3] 100 to BD[3] 150
	M450 fan[4]	Compact fan	M350	BD[3] 200 to BD[3] 350
	M500 fan[4]	Fan assembly	M500	BD[3] 400
	M1000 fan[4]	Fan assembly	M1000	BD[3] 500 to BD[3] 1000
	M2000 fan[4]	Fan assembly	M2000	BD[3] 1200 to BD[3] 2000
MOV	M200 MOV[2]	MOV	M100	BD[3] 25 to BD[3] 60
	M250 MOV[2]	MOV	M150	BD[3] 100 to BD[3] 150
	M350 MOV[2]	MOV	M350	BD[3] 200 to BD[3] 350
	M500 MOV[2]	MOV	M500	BD[3] 400
	M2000 MOV[2]	MOV	M1000	BD[3] 500 to BD[3] 1000
	M2000 MOV[2]	MOV	M2000	BD[3] 1200 to BD[3] 2000

Category	Code	Description	Mechanical size	Model
Spare Arms	380400/ARM	Thyristor Phase Arm	400A 380V	
	380500/ARM	Thyristor Phase Arm	500A 380V	
	380700ARM	Thyristor Phase Arm	700A 380V	
	3801000/ARM	Thyristor Phase Arm	1000A 380V	
	3801200/ARM	Thyristor Phase Arm	1200A 380V	
	3801500/ARM	Thyristor Phase Arm	1500A 380V	
	3802000/ARM	Thyristor Phase Arm	2000A 380V	
	525400/ARM	Thyristor Phase Arm	400A 525V	
	525500/ARM	Thyristor Phase Arm	500A 525V	
	525700/ARM	Thyristor Phase Arm	700A 525V	
	5251000/ARM	Thyristor Phase Arm	1000A 525V	
	5251200/ARM	Thyristor Phase Arm	1200A 525V	
	5251500/ARM	Thyristor Phase Arm	1500A 525V	
	5252000/ARM	Thyristor Phase Arm	2000A 525V	

8 SECTION 8 : SHIPPING AND STORAGE

8.1. GENERAL

The THYROMAT is simplistic in design and does not require any specialised packing, crates or procedures. When shipping or storing the system in high humidity conditions it is advisable to include a silicone gel sachet in the packaging to absorb any excess humidity.

8.1.1. Shipping

Complete unit. It is advised that the following procedure should be followed when packaging the THYROMAT for shipping purposes;

- Before wrapping the complete system, fold a section of bubble plastic to form a pad, tape the pad over the control unit's display and keypad to give it extra protection.
- Wrap the complete unit in bubble plastic or similar material.
- Place the complete wrapped unit into a strong cardboard box or suitable container.
- The unit is ready for shipping.

Components. It is advised that the following procedure should be followed when packaging the THYROMAT components for shipping purposes;

- Each electronic card must be handled carefully and inserted into it's own individual anti-static bag.
- Wrap the spare in bubble plastic or similar material.
- Place the complete wrapped spare into a strong cardboard box or suitable container.
- The spare is ready for shipping.

8.1.2. Storage

In the event that the Thyromat BD Digital Crane Controller or any spare component is stored then it is advised that the following procedure should be followed;

- Keep the ambient conditions in the storage area at an acceptable level (temperature from –40℃ to + 60 ℃ with a relative humidity less than 95%, no condensation allowed).
- Keep all equipment and spares in their respective packaging until such time that they are to be used.

9 SECTION 9 : ACRONYMS AND ABBREVIATIONS

9.1. GENERAL

The following list acronyms and abbreviations used throughout this manual.

%..... Percent
℃..... Degrees Celsius
A..... Amperes
ac ..... Alternating Current
Acc ..... Acceleration
C.D.F..... Cyclic Duration Factor
CPU ..... Central Processing Unit
CT ..... Current Transformer
dc ..... Direct Current
Dec..... Deceleration
Dly..... Delay
EEPROM ..... Electrically Erasable Programmable Read Only Memory
flc ..... Full Load Current
G ..... Gravitational Force
Hz..... Hertz (Cycles per Second)
I ..... Current
Ith ..... Thermal Current
K..... Coefficient value of rotor resistance that will give rated torque at standstill
kg ..... Kilograms
kW..... Kilowatt
LCD..... Liquid Crystal Display
m ..... Metres
mA..... Milli-amperes
MAX. ..... Maximum
mm ..... Millimetres
MPU ..... Motor Protection Unit
ms ..... Milliseconds
PID ..... Proportional Integral Derivative
PTC..... Positive Temperature Co-efficient
PVC..... Polly Vinyl Chloride
RAM ..... Random Access Memory
RMS ..... Root Mean Square
t ..... Temperature
Tn..... Torque (Motor)
Un ..... Supply Voltage
V..... Volts
W..... Watts